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CORRECTION: Vol. 1, No. 3, Pg. 33 - Image was identified incorrectly. Revised caption: *Lt Col James H. Doolittle and Capt Marc Mitscher on the deck of the aircraft carrier Hornet, 1942.*

COVER: The Air Force Space Command shoulder patch comes to life honoring the people and the hardware that mirror the past, present and future of the High Frontier. Air Force Art Program Artist: Norm Siegel

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"As we went to press, we learned of General Bernard A. Schriever's passing on 20 June 2005 at age 94. The men and women of Air Force Space Command dedicate this issue to the life and memory of General Schriever. Please see In Memoriam on page 54." **- General Lance W. Lord**

Introduction

Space Support to the Warfighter

General Lance W. Lord
Commander, Air Force Space Command

The difficulty of a task is no reason to avoid it.
- President George W. Bush

I recently came across a copy of the 1995 National Military Strategy for the United States of America. In it, one particular paragraph was tabbed, with the following words highlighted: *"Space forces play an increasingly important role in prosecuting modern warfare… Space assets…enhance the joint utilization of our land, sea, and air forces."* Next to the passage was a triangle with the words "Joint Warfighting" as the featured marquee; and at the corners of the triangle were the words "Land," "Sea," and "Air."

I think this is an excellent reminder of how far we've come over the last decade. We have evolved from a set of capabilities that, while useful, were not inextricably linked to the concepts of joint warfighting. Ten years later we see a very different picture. Today, the joint warfighter has a far greater appreciation for the combat effects generated from space assets. We have evolved from a set of capabilities touted as "interoperable," to providing combat effects deemed "interdependent." The difference is very important. The former means "you can," while the latter means "you must."

The fact is we still have a long way to go. While our role in military operations has evolved, we are now challenged to truly transform space support to the warfighter. Under the visionary leadership of Secretary of Defense Donald Rumsfeld and Chairman of the Joint Chiefs, General Richard B. Myers, and the unequivocal support of our Chief of Staff, General John P. Jumper, we are making the quantum leap toward affecting today's more complex and distributed battlespace. Our efforts are vital because our Nation's ability to defend itself relies heavily on our ability to employ the decisive effects our fighting forces have come to expect. We are pleased to report this is well underway.

Our framework includes far more than modernization and recapitalization efforts. Our programs are important, but I contend it is our forward thinking and innovative spirit that drives our mastery of the "technologically possible" while catapulting us to overcome what is currently "technologically impossible." Transformational space support to the warfighter can be achieved if we successfully merge the products of our innovation with a comprehensive, executable roadmap. To this extent, I offer a few perspectives of a multi-framed, multi-faceted strategy toward ***Providing Desired Combat Effects for Joint Warfighting.***

Integrated to Fight — Change within our organizational structure is usually driven by shifts in the environment. The 2004 National Military Strategy, released earlier this year, rightly identifies "integration" as a key principle guiding the development of our joint force. Integration must occur at every level. As we continue to mature technologies required to fully integrate space effects in the battlespace, we must also examine our existing organizational structures and processes.

We are close to implementing a Warfighting Headquarters structure in Air Force Space Command and establishing an Air Forces Strategic Command (AFSTRAT), and moving towards a single Air and Space Operations Center (AFSTRAT AOC). AFSTRAT will serve as a poised force, capable of acting swiftly, precisely, decisively, and globally. It will horizontally integrate a force structure capable of broad, flexible employment options across the full range of military operations. AFSTRAT is the next iteration of an air and space warfighting command, effectively bridging the gap between the air and space communities.

Another structural change underway is the merger of elements of the Space Warfare Center with the Air Warfare Center to become the new US Air Force Warfare Center. In addition, Air Force officials are looking at what information warfare capabilities might also fit into the integration. By integrating elements of these organizations, we effectively consolidate key warfighting assets into one organization, which will create a warfighting synergy that increases combat effectiveness and peacetime efficiencies. We are confident this new organization will be better postured to maximize and leverage the distinct advantages of space, information operations, and air combat capabilities to support the joint warfighter.

Operationally Responsive — Going beyond organizational constructs, we must closely examine our internal programs and processes. We must refresh our "*High Frontier*" mindset and apply critical thought toward developing new, innovative ways to increase our operational responsiveness. Based on the Space C4ISR CONOPS and capability assessments, it is clear we need to improve space response to operational and tactical level commanders. Our culture has been one where space assets are "global" and not necessarily "dedicated" to any one particular theater. Given today's environment of a growing interdependence on space capabilities, our traditional cultural perspective is changing. That is why we are working hard on General Jumper's innovative and visionary concept known as Joint Warfighting Space (JWS).

JWS is a rapid reaction, networked space constellation, dedicated to the joint force commander and integrated with National Security Space (NSS) systems. The primary elements are: (1) rapid launch within hours; (2) tactical satellites (TacSats) integrated at the machine level with UAVs, space platforms, and surface and airborne C2; and (3) focus on a particular theater

or area at the request of the Combatant Commander. The system could be optimized to provide persistent collection (augmenting reconnaissance platforms), predictive awareness during emergency crises, and dedicated real time target location, identification, tracking and engagement.

Implementing such a concept required a dramatic and fresh review of our current doctrine, organization, training, materiel, leadership, personnel and facilities. This review has produced a new paradigm called Operationally Responsive Space (ORS). Our industrial base is already on board producing innovative ideas in the areas of Responsive Small Spacelift. One such booster, known as Falcon I, may offer breakthrough improvements in cost and reliability. Furthermore, efforts to demonstrate a variety of new capabilities using a much smaller, tactical satellite model (TacSat I) should help us validate many of the future operational concepts currently in development. TacSat I is scheduled to launch on Falcon I later this summer.

We continue to explore new capabilities in the area known as "Near Space" at an altitude between 65,000 to 325,000 feet. These Near Space platforms are not intended to replace air or space assets, but rather to augment and integrate existing capabilities. Once operational, these platforms could provide the much needed persistence and direct support to our theater commanders and their joint warfighters. Finally, initiatives exploring the employment of conventional weapons using ballistic missiles offer promise to combatant commanders looking for a US-based Prompt Global Strike capability.

As you can see, JWS includes a wide variety of concepts and initiatives that challenge our thinking. Our new perspective is one of operationalizing space to directly benefit the warfighter through an agile, responsive, commander-oriented, combat space vision-focused primarily at the tactical and operational levels of war.

Trained and Educated — Because the future of our profession promises to be the most dynamic in its history, Space Professional Development is more important than ever. If we are to be successful, we must continually improve our ability to groom the men and women who make up our Space Professional.

It is no coincidence we are deploying more space professionals into theater than ever before. The more than 1600 men and women of Air Force Space Command, who deployed in support of Operations ENDURING FREEDOM and IRAQI FREEDOM, know well the challenges and rewards of theater operations integration. Experiencing "first-hand" the intricacies at work within the Air and Space Operations Center yields an exceptional appreciation for the critical effects we provide. The expeditionary nature of our service must extend to include all space professionals if we are to fully embrace and comprehend the complexities of joint warfare.

While the school of "experience" has a propensity to be intensely educational, we cannot afford to wait for such rare opportunities in order to develop our people. The 2001 Space Commission Report hit the mark when it stated space operators and acquirers must "master highly complex technology…and operate some of the most complex systems ever built and deployed." Moreover, future military operations promise to be progressively more complex, with an operations tempo that surpasses the benchmarks set by "shock and awe." As we place more space combat capability in the hands of our theater commanders, it becomes increasingly imperative to provide space warfighters that are both qualified and credentialed. This is precisely why our space professional development strategy addresses both the need for joint warfighting expertise and highly advanced curriculum. Such a strategy is the only way we can derive maximum utility from current space systems and ensure future systems will provide the decisive combat effects upon which our theater commanders depend.

General Lance W. Lord (BS, Otterbein College; MS, University of North Dakota) is the Commander of Air Force Space Command, Peterson Air Force Base, Colorado. General Lord is responsible for the development, acquisition and operation of Air Force space and missile systems. The general overseas a global network of satellite command and control, communications, missile warning and launch facilities, and ensures the combat readiness of America's Intercontinental Ballistic Missile (ICBM) force. The general has commanded two ICBM wings and a space launch wing and served as the Commandant of Squadron Officer School and Commander of Air University. Prior to his current position, General Lord was the Assistant Vice Chief of Staff for Headquarters US Air Force. The general is also a graduate of Squadron Officer School, Air War College and a distinguished graduate from Air Command and Staff College.

I encourage you to spend the time thinking about the material published in this issue of the "*High Frontier*." We've had an absolutely overwhelming response to our request for articles and, regrettably, we were unable to publish every submission in this issue. The articles that follow were chosen to provide you with a wide-ranging array of information on a variety of issues that will challenge our corporate intellect. This issue features some of the most highly acclaimed experts in our business. I know you will thoroughly enjoy learning from their experiences and growing as a space power advocate.

Thank you for allowing me the opportunity to share my thoughts on what I believe is one of the most critical areas of growth in our command. **Space Superiority**, featured in last quarter's edition, and **Providing Desired Combat Effects for Joint Warfighting** are top priorities. We have a great deal to accomplish, and it will be challenging. But as President Bush said at his Inaugural Address earlier this year, "The difficulty of a task is no reason to avoid it." He was speaking about the Global War on Terrorism, which should serve as a pointed reminder of the importance of our work.

Senior Officer Perspective

Providing Combat Effects to the Battlefield

Lt Gen Dan P. Leaf
Vice Commander, Air Force Space Command

Since the early days of conflict, warriors have recognized the importance of controlling the high ground of a battlefield. Initially, the high ground took its literal form of hills and elevated terrain. During the Civil War, both sides conducted reconnaissance from balloons in an attempt to gain a better vantage point. World War I saw the advent of aerial warfare, beginning with pilots carrying pistols to shoot at other airplanes as they conducted reconnaissance and primitive aerial bombing campaigns. World War II was the first war where air power became a central focus in warfighting operations and air became the high ground. Following WWII, higher altitudes and space supplanted air as the high ground and the space race began. Today, space is the ultimate high ground and it has changed the way we fight wars.

Air Force Space Command (AFSPC) is responsible for ensuring the United States controls that high ground by gaining and maintaining space superiority. For many years, space was a sanctuary where we could operate freely without any threat or attempt to deny our use of space, but that has changed. As we saw with Iraqi attempts to jam the Global Positioning System (GPS) signal during Operation IRAQI FREEDOM, our enemies will challenge our space superiority. We must be prepared to answer that challenge and a key piece of our preparation is to develop a warrior attitude.

As an aviator in the Balkans during Operation ALLIED FORCE, and then as the air component coordination element (ACCE) with the Combined Forces Land Component Commander during Operation IRAQI FREEDOM, I reaped the benefits of space and I saw them change the way we conduct operations.

The first area where I gained a true appreciation for space was as an F-16 pilot employing laser guided bombs. In a multi-role fighter such as the F-16, the pilot is often task-saturated at critical points such as the initial point on the run in to a bombing target. The reliability of space based imagery combined with the accuracy of GPS gave me confidence that the F-16's targeting system would automatically acquire the target at the initiation of the bombing run, allowing me to concentrate on the many other tactical tasks at hand, such as recognizing the exact desired point of impact, releasing the bomb and reacting to any threats. Only towards the final moments of the bombing run did I have to focus on fine tuning the aiming. Thanks to space, I could focus on other tasks, which made me more effective on bombing missions and kept me safer in the process.

During operations in the Balkans, the United States experienced the first ever combat loss of an F-117 Stealth Fighter, plus two other losses of F-16 aircraft. As with all downed aircraft, safe recovery of the downed airmen was the number one priority. In every one of those combat search and rescue (CSAR) operations, space played a critical role in ascertaining the location of the downed airman and they were all rescued safely. The role of space in CSAR continued during Operation IRAQI FREEDOM, when a Navy aircrew was forced to eject from their disabled F-14. Space ensured we not only had the location of the downed aircrew, but also gave our rescue aircraft situation awareness on the surface-to-air threats. Thanks to space, the two naval aviators were rescued within 90 minutes of ejecting. As General John P. Jumper put it, "space took the search out of search and rescue."

As the ACCE to the Combined Forces Land Component Commander during Operation IRAQI FREEDOM, I experienced the truly joint nature of space. For ground maneuver forces, GPS has become a staple of navigation and very few, if any, units do not use GPS to navigate. Additionally, we saw many examples of GPS allowing for aircraft to support ground troops. In one particular incident, units from the US Army's 7th Cavalry Regiment were engaged in an intense fire fight with Iraqi forces near An Najaf. The American forces were surrounded on three sides, with the fourth side closing in quickly. The problem was compounded by near zero visibility caused by a sandstorm and darkness. Using satellite communications, the American forces requested close air support to break the enemy attack. A B-1 bomber dropped two GPS aided Joint Direct Attack Munitions (JDAMs) on the enemy forces, which broke the enemy's attack without a single American life lost in the battle.

Those experiences have given me an appreciation for the effects space provides, but until my assignment to AFSPC, I did not have an appreciation for the growth and challenges of space and the efforts of the space community to fully integrate space into all aspects of joint operations. During my 18 months in AFSPC, I have come to fully appreciate the efforts of the space community to advance space and have been transformed into a space and missile zealot. I believe space today is at a very similar point as air power was following World War I. There is no debate as to space's utility or importance, but we are still working to fully develop an identity and the most effective means of employment.

As AFSPC transitions to a "combat" command, we must ensure we adjust our mindset accordingly. Space is no longer a supporting, add on capability--we are a combat command that delivers effects to the battlefield. Our Intercontinental Ballistic Missile (ICBM) crews already have that mindset, and now we must all adopt it.

Before I came to AFSPC, I did not have a true appreciation for ICBM operations. Like all airmen, I was aware of the missile force's role in strategic deterrence, but the process and inner

workings of the missile force were transparent to me. I lived and operated under the umbrella of security ICBMs provided, but only since coming to AFSPC have I seen the intangible attributes that the ICBM community contributes to our Nation.

One of the greatest qualities of our ICBM crews is their "combat sense." Because they are on the front lines of our Nation's strategic defense on a daily basis, our missile crews have developed a combat edge. Their focus on being ready to deliver precise, devastating firepower at a moment's notice is second to none. Our ICBM crews truly understand what it means to be combat ready.

The second trait in our ICBM crews that I find remarkable is their unmatched discipline. By necessity, the nuclear and ICBM business is guided by strict processes and checklists that our missile crews take to heart. The ability of our missile crews to adhere to a specific, precise procedure, even under the most stressful situations, is truly laudable.

Those two qualities, "combat sense" and "combat discipline," create a lethal fighting force that has ensured the security of the United States for more than 55 years. As the days of the Cold War ended, many people questioned the need for maintaining an ICBM force. Although the face of our strategic adversaries has changed during the past 15 years, the importance of Land Based Strategic Deterrence (LBSD) remains and will not go away in the near future. Although the weapon systems used for LBSD may be modernized and changed, combat sense and combat discipline will remain the foundation of a strong, prepared fighting force.

Somewhat in contrast to the strict discipline of missiles, the space operations mission fosters a sense of creativity that leads our space professionals to develop new means of using existing capabilities for an ever changing combat environment. That spirit of creativity was born of necessity as we began to use space systems that were designed for strategic use in the Cold War to achieve operational and tactical level objectives during Operation DESERT STORM and, more recently, Operations ENDURING FREEDOM and IRAQI FREEDOM. It is important to retain that creativity, even as space systems are now better designed to accomplish the missions for which we are using them. The combat arena will remain extremely dynamic and our system designs need to keep pace with the dynamics of the battlefield.

In order to form a true "combat culture," the space community must meld the combat sense and discipline of the missile culture with the creativity of the space operations community. While creativity and strict checklist discipline may seem diametrically opposed, I believe they are complementary and becoming a truly great, successful fighting force depends largely upon finding a delicate balance between the two. That ever-changing balance between them can only be accomplished by credentialed warriors and it is critical for the space community to develop that mindset.

Understanding how the effects we provide contribute to overall mission success is a fundamental step in developing and honing a combat edge. We must improve our understanding of combat operations being conducted in theater and how space impacts those operations. GPS crews must understand the effects they provide to air, land and maritime forces and the ramifications of losing that precision navigation and timing signal. Crews from the 2^{d} Space Warning Squadron must fully comprehend how their data is used for missile warning and battlefield characterization. Communications satellite operators should understand the importance of the communications links they provide and how the unique attributes and limitations of that particular frequency range impact users. Every space and missile professional must extend their knowledge beyond their weapons system to the impact of their "effects" on joint warfighting operations.

In addition to educating our space professionals, we must help the rest of the military understand what space brings to the fight. That understanding will come about through deliberate crisis action planning and education, which will allow those joint forces to more fully exploit the advantages space provides. AFSPC is bridging the education and planning gap and we must continue those efforts.

Space provides global effects and the entire world is our theater of operations. Conducting combat operations using space assets may not always require deploying to the immediate theater where the conflict is taking place, but that does not diminish its importance. Required battlefield effects can be generated from bases in the United States. We must not let our geographic separation from the theater of operations detach us from the criticality of our mission. Every space professional should understand the role he or she plays in the success of combat operations and we should feel a great sense of mission accomplishment for our contributions. After 28 years of passion for airpower, I have developed an equal, abiding passion for space power and we should all take great pride in space's contribution to the defense of freedom.

Lt Gen Dan P. Leaf (B.S., University of Wisconsin-Madison; M.A., Army Command and General Staff College, Fort Leavenworth, Kansas) is the Vice Commander, Air Force Space Command, Peterson Air Force Base, Colorado. He assists the Commander in the development, acquisition and operation of the Air Forces' space and missile systems. General Leaf also directs and coordinates the activities of the staff. He also commanded a flight, two squadrons, an operations group and two fighter wings, and has directed joint operations.
General Leaf is a command pilot with more than 3,600 flying hours, including Allied Force, Joint Forge, Northern Watch and Southern Watch combat missions. Squadron Officer School, Honor graduate, US Army Command and General Staff College, Fort Leavenworth, Kansas. Outstanding graduate, Air War College by correspondence, and Air War College in residence, Maxwell Air Force Base, Alabama.

Leveraging Space to Support the Changing Paradigm

LTG Larry J. Dodgen
Commander, US Army Space and Missile Defense
US Army Forces Strategic Command

The Army's early use of space was to support strategic communications, serve as a conduit for reporting warnings of attack and strategic nuclear targeting, and for arms control and verification. The complexity and expense of the capabilities involved in these earlier efforts meant they were limited in quantity and restricted to a few users at the higher echelons. However, decades of advancement in space technology have drastically changed the landscape and the "spacescape."

During the past two decades, space technology and services have increased tremendously in their availability, variety, and capability. As a result, space capabilities now affect nearly every facet of our daily lives. Space technologies have made possible, or vastly improved, products and services in the marketplace such as cellular telephones, video teleconferencing, satellite-based radio, and handheld and vehicle-installed Global Positioning Systems (GPS). Likewise, international stock market transactions, accurate weather forecasting, and live television broadcasts from overseas locations depend on capabilities derived from space systems.

The value of space support to our Nation's security has gained increased recognition. The *Phase III Report of the US Commission on National Security/21st Century* emphasized this view with the statement: "The military cannot undertake any major operation, anywhere in the world, without relying on systems in space."[1] Recently, General James E. Cartwright, Commander, US Strategic Command (USSTRATCOM), stressed this point with the comment, "The importance of the space mission to our national security cannot be overstated. The US economy, our quality of life, and our nation's defense are all linked to our freedom of action in space."[2]

Joint warfighters now rely on assured access to responsive and timely space-based capabilities. During the major combat phases of Operation IRAQI FREEDOM, space-based assets provided our military forces with robust and uninterrupted satellite communications (SATCOM), around-the-clock intelligence, surveillance, and reconnaissance (ISR), accurate and responsive weather reporting, and near-real-time positioning, navigation, and timing (PNT) data. From the provision of humanitarian assistance in support of the tsunami catastrophe in Southern Asia to the house-to-house fighting in Fallujah, Iraq, space is serving as the "medium of choice" for timely delivery of products and services to support military decision-making, planning, and decisive combat operations. In fact, space-based products and services are now so commonplace in our military operations that the means by which they are delivered are often transparent to the recipients.

The Army's Space Forces: Space to Mud

Within the Army, the US Army Space and Missile Defense Command (USASMDC) is the specified proponent for space. In addition to its Title 10 Army responsibilities, this Command as Army Forces Strategic Command (ARSTRAT) also serves as the Army Service component command (ASCC) to USSTRATCOM. As ASCC, USASMDC/ARSTRAT conducts space operations and provides planning, integration, control, and coordination of Army forces and capabilities in support of USSTRATCOM missions of Space; Global Strike; Global Integrated Missile Defense; Global Information Operations; and global command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR). The commander, USASMDC also serves as the commander of USSTRATCOM's Joint Functional Component Command for Integrated Missile Defense (JFCC IMD). The JFCC IMD conducts planning, coordination, and integration of global ballistic missile defense (BMD) operations and recommends desired missile defense capabilities to support missile defense operations of the geographical combatant commands. We are working closely with the planning staffs at USSTRATCOM, the Missile Defense Agency, and other combatant commands to ensure global BMD plans and operations are fully integrated. Integration of space capabilities coordinated by JFCC Space and Global Strike will be vital to the JFCC IMD. We are on track to achieve full operational capability by the end of September 2005.

An extensive variety of space forces and capabilities are assigned to USASMDC/ARSTRAT. These forces and capabilities are located in Colorado Springs, Colorado and

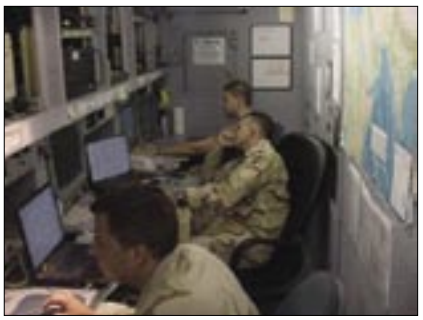
Soldiers perform system checks of satellite communications equipment that support joint warfighters.

multiple worldwide locations and are supported by the command's research, development, and acquisition activities that are predominantly located in Huntsville, Alabama.

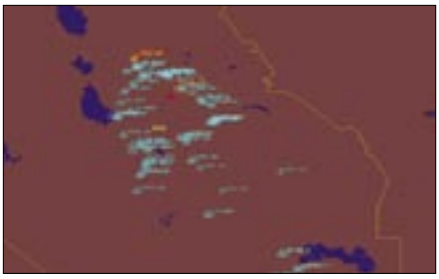
The 1st Space Brigade (Provisional) provides to combatant commanders the soldiers, civilians, and equipment that enable access to a wide variety of space-based products and services. The brigade's three battalions – the 1st Space Battalion, the 193d Space Support Battalion (Colorado Army National Guard), and the 1st Satellite Control Battalion (to be redesignated as the 53d Signal Battalion in October 2005) provide force enhancement and space control capabilities. The Regional Satellite Communications Support Centers and the Defense Satellite Communications System Operations Centers, in the continental United States (CONUS) and overseas locations, provide reliable and responsive SATCOM support. The USASMDC/ARSTRAT Operations Center maintains around-the-clock situational awareness of deployed elements, responds to requests for information, and provides reach-back connectivity with technical subject matter experts. USASMDC/ARSTRAT also has a Joint Mission Management Center that provides 24/7 space-based Joint Blue Force Situation Awareness (JBFSA) support to the Services, regional combatant commanders, and other government agencies on behalf of USSTRATCOM. USASMDC/ARSTRAT's research, development, and acquisition organizations perform essential roles in providing "concept to reality" space and missile defense technological solutions in support of combatant commanders, the Missile Defense Agency, and several other organizations.

USASMDC/ARSTRAT's 100th Missile Defense Brigade (Ground-based Midcourse Defense) exemplifies the inextricable linkage between space and missile defense. This unit, with its headquarters in Colorado Springs, Colorado, and its subordinate 49th Missile Defense Battalion located at Fort Greely, Alaska, operates the ground-based portion of the integrated ballistic missile defense system (BMDS). In concert with our sister Services' missile defense capabilities, the BMDS will provide a layered defense for our homeland, deployed forces, friends, and Allies against ballistic missiles of all ranges in all phases of flight. Using complementary interceptors, land-, sea-, air- and space-based sensors, and battle management command and control systems, the BMDS will be able to engage all classes and ranges of ballistic missile threats and through all phases of flight. Space-based assets are vital to ensuring the connectivity and early warning for the BMDS.

USASMDC/ARSTRAT also provides early missile warning and missile defense support. The 1st Space Brigade's Theater Missile Warning Detachments man the joint tactical ground stations (JTAGS) with Army and Navy personnel. The JTAGS provide direct in-theater downlink from Defense Support Program sensor satellites and monitor enemy missile launch activity and other infrared events of interest. This information is shared with members of the air and missile defense and operational communities.



Joint Tactical Ground Station (JTAGS) members man the watch at US Central Command in Doha, Qatar.



A Common Operating Picture generated by the space-based blue force tracking device Grenadier BRAT enables commanders to have enhanced situation awareness.

Supporting the Current Fight

The 21st century is showing itself to be an era of great uncertainty and unpredictability. The ongoing Global War on Terrorism (GWOT) and continued unrest and instability in multiple locations around the world illustrate the increased complexity of our times. Persistent and emerging challenges arise from a range of threats, including hostile state and non-state actors. This new security environment includes traditional threats as well as adversaries with access to advanced weaponry and technology, including global communications, space-based spectral imagery, and automation capabilities. These capabilities in adversaries' hands dramatically increase the variety and intensity of threats to the US homeland, our military forces, and our nation's global interests. Access to these advanced capabilities also affects the way our enemies fight.

Our military forces in Afghanistan and Iraq are now fighting insurgent forces that employ asymmetric warfare and insurgent tactics. The enemy's use of face-to-face communications supplemented by cell phones, reliance on austere logistics, and collocation with the civilian population while exploiting mass media challenge our ability to locate and engage them. As a result, the manner in which we used our advanced technologies with such resounding military success against the Taliban and Baathist regimes must evolve to support joint warfighter requirements in the battle against insurgent forces.

Providing relevant support to our warfighters means furnishing them with the capabilities they need to defeat enemy forces. Joint warfighters need the capabilities that allow them to pursue the enemy around the clock, and space-based capabilities are an essential component of this support. Secretary of Defense Donald H. Rumsfeld recently noted the increased importance of space when he said, "Over the past few years we have recognized that space and information are not only enablers, but core warfighting competencies."[3]

The key to effective support of warfighters is using the high ground of space to provide relevant products and services integrated into all phases of military operations. Supporting these operational requirements requires space-based systems in areas related to persistent surveillance, satellite communications, JBFSA, ISR, PNT data, spectral imagery, missile warning, and space control. Identifying the most relevant operational

requirements for warfighters is an ongoing process, but five areas define the majority of current needs.

- **Warfighters need timely access to actionable information.** Commanders and soldiers at all levels must have timely and accurate information about their own locations, the locations of their forces, other friendly forces, and the enemy. Three timeless questions – "Where am I? Where's my buddy? Where's the enemy?" – lie at the heart of the information requirements. Answering these questions provides enhanced situation awareness and knowledge of the environment, the enemy, and friendly forces.
- **Support must be flexible.** Rapidly evolving combat situations demand responsive and tailorable solutions. First, warfighters must seek to use existing systems in new ways and by applying new ideas. Second, we must increase the dialogue between warfighters and materiel developers to ensure that future systems and modifications to existing systems meet warfighters' needs.
- **Support must be provided within a joint context.** Service capabilities that combine complementary and reinforcing effects while minimizing relative vulnerabilities enable the delivery of synergistic combat power greater than the sum of the individual parts. This is the essence of jointness and interdependence, and the Army is fully committed to this operational concept. General Peter J. Schoomaker, Chief of Staff, Army, has emphasized this point, "Our collective future is irrefutably joint. To meet the challenges of expeditionary operations, the Army can and must embrace the capabilities of its sister Services right down to the tactical level."[4]
- **Support must be deliverable to warfighters on the move in an asymmetric environment.** In conventional military operations, enemy forces are generally easier to find and destroy during insurgent operations. Relatively large military formations and their equipment usually operate in terrain favorable to maneuver. They also emit a variety of electro-magnetic signatures subject to interception and have physical attributes that make them visible to detection. These identifying characteristics allow warfighters to assemble a measured amount of military capability to neutralize or destroy the adversary's combat power. In contrast, insurgents operating in small groups or as individuals in "complex terrain" are often hidden in the larger population. Identifying and targeting these small groups or individual insurgents – barely distinguishable from the civilian population – present a distinct challenge. Warfighters require capabilities that allow them to use actionable information in an effective manner against this adaptive enemy.
- **Support must be provided "in time" to be relevant to warfighters.** In an effort to expedite relevant support, technologies and capabilities being developed to support the future force are being leveraged to support current force requirements. The Army is aggressively implementing several initiatives in an effort to speed technological solutions in support of our deployed warfighters. We are pursuing specific science and technology initiatives to enhance situation awareness and determine the origins and likely impact points of enemy missiles.

"Over the past few years we have recognized that space and information are not only enablers, but core warfighting competencies."

- Donald H. Rumsfeld, Secretary of Defense

The Case for Transformation

Because our future adversaries are unlike those of the past, our concepts of operations to fight them must also be different. Previously, space resources were only available to senior leaders of technically advanced nations, all state and non-state actors now have access to space products and services that nearly rival those of the United States. Our adversaries are learning to exploit space to their own advantage through the commercial sector of space. As a result, adversaries can obtain space-based capabilities like SATCOM and high-resolution imagery without owning any satellites. Opponents may also attempt to counter our Nation's military strengths by attacking or exploiting perceived weaknesses, especially our dependence on C4ISR capabilities. The proliferation and potential use of weapons of mass destruction, which President George W. Bush described as "the greatest threat before humanity today," also pose distinct challenges to our Nation's economic and social prosperity.[5]

We have increasingly seen our adversaries acquire the ability to conduct operations against our space-based capabilities. The necessity for robust space control capabilities is growing, a fact emphasized more frequently by the Air Force and Army. As an example, General Lance W. Lord, commander, Air Force Space Command, recently noted, "We saw Saddam Hussein try to jam GPS signals during Operation IRAQI FREEDOM. We've got to be capable of understanding that, detecting that, and then taking the right kind of actions to prevent somebody trying to use that against us."[6]

Our military's missions are fundamentally changing. The Army is transforming in the context of this evolving threat in order to prepare for the national security challenges of the 21st century. General Peter J. Schoomaker has stated, "we will not be effective and relevant in the 21st century unless we become much more agile but with the capacity for a long-term, sustained level of conflict."[7] In today's complicated and uncertain world, it is impossible to predict the exact nature of future conflicts that might involve our military forces. As a result, the Army is transforming to ensure it is ready to meet the challenges of any type of conflict, in all kinds of places, and against all kinds of conceived threats. This transformation, often described as the

most comprehensive in the last 50 years, will require the most technologically significant structural change in the Army's 230 year history. The fact that transformation is under way while the Army is engaged in the GWOT affirms the effort's importance.

The transformed Army will have tailorable – *modular* – units with improved deployability and increased lethality. These lighter, highly mobile, and survivable formations will fight as self-contained units in non-linear, non-contiguous battlespace. Units will have the ability to arrive at multiple austere points of entry via air and sealift, and possess "off the ramp" capabilities to strike the enemy's centers of gravity simultaneously. The Army's Future Force, serving as part of the joint force, will leverage the capabilities of space, land, sea, and air power. The result will be a force that is strategically responsive and dominant at every point on the operational spectrum in its ability to *See First, Understand First, Act First, and Finish Decisively.*

Peter B. Teets, former Undersecretary of the Air Force, recently noted, "Our goal is transparency – we want the ability to see everything and know everything, while simultaneously denying our adversaries both the ability to do the same, and the knowledge that such capabilities are being used against them. We want to be always one step, or more, ahead of our adversaries."[8] Space is an integral part of the Army's Future Force. Army space operations will focus on five essential tasks to ensure the achievement of decisive victory.

- **Support increased deployability and reduced theater footprint.** Arriving forces will rapidly move through logistically austere entry points en route to immediate employment. A logistical construct with reduced force structure and physical presence will provide support through reach-back and distribution-based sustainment.
- **Enabling situational understanding en route as well as off the ramp during entry operations.** Global, robust, near real-time joint intelligence sensor networks integrated space-to-mud will provide improved understanding and persistent surveillance. Tactically responsive capabilities will provide situation awareness while on the move. Assured communications will enhance the lethality, survivability, and operational tempo of the warfighter. The systems that will ultimately provide these capabilities must be dynamically taskable in theater and have the ability to provide actionable intelligence to the warfighter at multiple locations. The Internet-based Global Information Grid, a state-of-the-art global communications network, will support this architecture.
- **Support of precision maneuver, fires, sustainment, and information on a non-linear battlefield.** Friendly forces will attack enemy centers of gravity with precise effects to defeat our adversary. We will conduct simultaneous operations throughout the joint operations area.
- **Enabling continuous information and decision superiority.** Joint, integrated battle command will enable decision superiority. Joint operations enhanced by pervasive access to wideband communications will achieve greater synergy.
- **Protecting the force during all phases of the operation.** Opportunities exist through all phases of combat operations for enemy forces to impede or disrupt our freedom of action. Space-based capabilities can contribute to denying the enemy access to information and the means to inhibit our military mission. These capabilities can also provide early missile warning and facilitate our freedom of maneuver during combat operations.

The Army's Future Force, serving as part of the joint force, will be adaptable and lethal, leveraging the capabilities of space. As a space-empowered force, future force units – Brigade Combat Teams and Units of Employment (UEx and UEy) – will routinely exploit the overhead constellation of national, commercial, and military space and near space platforms. In particular, the future force will rely on knowledge-based networks that are vertically and horizontally integrated from strategic to tactical levels. Warfighters will also have access to near real-time actionable intelligence, terrestrial and space-based sensors, focused surveillance, area reconnaissance, wideband SATCOM, missile warning, PNT data, JBFSA, weather/terrain/environmental monitoring, and space control. To a great degree, space-based systems will deliver these required capabilities.

Astronaut Colonel Patrick G. Forrester, STS-105 mission specialist, waves at a crewmember inside Discovery's cabin during one of two sessions of extravehicular activity (EVA).

One of the steps to "operationalize space" into the future force is establishment of an organic Space Support Element (SSE) in each of the Army's reorganizing UEx and UEy. This action begins the Army's integration of space capabilities and operations into planning, exercises, training, and all phases of combat operations. The first SSE, organic to the 3d Infantry Division, was certified in September 2004 and deployed with the unit to Iraq in January 2005. Ten additional UEx SSEs (within the Army's force structure) as well as several UEy SSEs will be established by the end of Fiscal Year 2007.

Officers serving with Army Space Support Team 14 take a moment to relax during their deployment in Iraq.

The SSE, as part of a joint theater space architecture, will become the focal point for maximizing space-related capabilities to support tactical requirements in conjunction with joint, interagency, and multinational organizations and non-governmental organizations. The SSE, composed of Space Operations officers and Satellite Communication Systems Operator-Maintainer noncommissioned officers, will be trained and equipped to provide organic space expertise in the areas of deliberate and crisis action planning, theater exercises, operations, and support to the theater engagement strategy. These SSEs will be further augmented by additional Army Space Support Teams (ARSSTs) assigned to the 1st Space Brigade.

Although the Army is fully committed to operationalizing space within its own forces, promising work is also being done in the area of joint command and control of space forces. The JFCC-Space and Global Strike joint space operations center and regional space coordination cells are emerging concepts that the Army fully embraces.

The Army Space Cadre: Leveraging Relevant Space Capabilities to Joint Warfighters

The successful toppling of Saddam Hussein's repressive regime occurred not only because of superior technology. It also occurred because of the collective efforts of well-trained and well-led joint warfighters who were supported by space professionals.

Significant organizational changes have occurred as the Army's – and the Nation's – view of space has evolved. In 2001, the Commission to Assess United States National Security Space Management and Organization (the Space Commission) recommended changes in the Department of Defense. In the report's conclusion, the Space Commission emphasized the need to develop a cadre of well-trained space professionals to encourage innovation and secure proper management of space systems. Additionally, the Commission recommended the military departments enhance Space Professional Military Education at all levels to ensure increased integration of space activities into all military operations.[9] Secretary of Defense Donald Rumsfeld subsequently directed organizational changes be made to consolidate and streamline space operations.

The Army recognized the value of a cadre of space-qualified officers with the establishment of the Functional Area (FA) 40 Space Operations Officer career field in December 1997 in support of Officer Personnel Management System XXI. Implicit in this action was the Army's realization that an understanding of space systems and capabilities was increasing in importance as part of the professional soldier's skill set.

USASMDC is the Army's personnel proponent for FA 40 officers, the Army's space cadre today. To date, more than 150 Army officers have received the career field designation as a FA 40 space operations officer. These officers serve in 29 different Army and joint commands and Department of Defense organizations across tactical, operational, and strategic echelons, contributing significantly to enhancement of combatant commanders' warfighting capabilities. The Army's space cadre also includes the officers assigned to the Army astronaut detachment serving with the National Aeronautics and Space Administration (NASA) Johnson Space Center in Houston, Texas. Six Army astronauts support NASA. The Army is currently conducting a rigorous analysis of whether and how its space cadre should be expanded. This study will examine the feasibility of adding additional officers, and including enlisted personnel and Department of the Army civilians to the cadre.

"We will not be effective and relevant in the 21st century unless we become much more agile but with the capacity for a long-term, sustained level of conflict."

- General Peter Schoomaker

Spearheaded by the Space Operations Officer Qualification Course, a robust space education program is now a part of Army Service school curricula. This education provides a relevant, fundamental level of space knowledge to officers, noncommissioned officers, soldiers, and civilians. As a result, soldiers are becoming more knowledgeable, skilled, and confident in working with space systems and products.

Establishment of FA 40, formation of the Army's space cadre, conduct of the Army's Space Operations Officer Qualification Course, training and deployment of ARSSTs, and establishment of the new SSEs are testaments to the Army's realization of the importance of space to warfighting. This realization is further emphasized in the close relationship that has been forged between the Air Force and Army to enhance the professional development of the FA 40s. In coordination with the Air Force, we have begun integrating Army space education into the National Security Space Institute. Better training opportunities

"We saw Saddam Hussein try to jam GPS signals during Operation IRAQI FREEDOM. We've got to be capable of understanding that, detecting that, and then taking the right kind of actions to prevent somebody trying to use that against us."

- General Lance W. Lord

for Army space professionals have also been developed because of this enhanced relationship.

Future Prospects and Expanding Opportunities

Although no one can predict the future with assurance, the need for greater emphasis on homeland security, the ongoing GWOT, and commitments in logistically austere locations will likely define our near future. The next decade will continue to be an innovative and rewarding time for space professionals.

Operationally, space is – and will remain – an essential capability for our joint warfighters. Space is a vertical extension of the battlefield and space-based enablers are essential to our capabilities. The evolving nature of the threat and advances in technology have made space essential to our success. Space enables us to see and act more quickly, and our responses to situations can now occur more rapidly and decisively. Space capabilities have become and will continue to be linked to warfighting. The inextricable linkages between space and missile defense will continue.

The USASMDC – the Army proponent for space and missile defense, and ASCC to USSTRATCOM – is a full member of the joint team. The men and women of USASMDC/ARSTRAT look forward to the future and our important role in maximizing the potential of space in support of our joint warfighters. **Secure the High Ground!**

Notes:

[1] "Road Map for National Security: Imperative for Change," *The Phase III Report of the US Commission on National Security/21st Century*, 15 February 2001, 78, on-line, Internet, 3 December 2004, available from http://www.au.af.mil/au/awc/awcgate/nssg/phaseIIIfr.pdf.

[2] General James E. Cartwright, testimony before the Strategic Forces Subcommittee of the Senate Armed Services Committee, 4 April 2005, cited in American Forces Press Service, on-line, Internet, 5 April 2005, available from http://aimpoints.hq.af.mil/display.cfm?id=2270.

[3] Donald H. Rumsfeld, Secretary of Defense. Remarks. Association of the United States Army-sponsored Space and Missile Defense Symposium in El Paso, TX, 10 December 2003, on-line, Internet, 13 December 2004, available from http://www.globalsecurity.org/space/library/news/2003/space-031210-afps01.htm.

[4] General Peter J. Schoomaker, *Serving a Nation at War: A Campaign Quality Army with Joint and Expeditionary Capabilities*, on-line, Internet, 25 March 2005, available from http://www.army.mil/jec/2_strategiccontext.html.

[5] President George W. Bush. Remarks. Weapons of Mass Destruction Proliferation at Fort Lesley J. McNair, National Defense University, Washington, D.C., 11 February 2004, on-line, Internet, 5 April 2005, available from http://www.whitehouse.gov/news/releases/2004/02/20040211-4.html.

[6] General Lance W. Lord. Quoted. "Space Efforts are Crucial to US, General Says," *The Oklahoman*, 29 March 2005, on-line, Internet, 4 April 2005, available from http://aimpoints.hq.af.mil/display.cfm?id=2270.

[7] General Peter J. Schoomaker, "The Army's Challenge," *Military Officer*, on-line, Internet, 29 March 2005, available from http://www.moaa.org/Magazine/November2004/f_schoomaker.asp.

[8] Honorable Peter B. Teets, Under Secretary of the Air Force. Testimony. Senate Armed Services Committee Hearing on National Security Space Programs, 12 March 2003, on-line, Internet, 30 March 2005, available from http://www.fas.org/irp/congress/2003_hr/031203teets.html.

[9] *Report of the Commission to Assess United States National Security Space Management and Organization*, 11 January 2001, 33-34, on-line, Internet, 14 December 2004, available from www.defenselink.mil/pubs/space20010111.html.

LTG Larry J. Dodgen assumed command of the US Army Space and Missile Defense Command/US Army Forces Strategic Command in December 2003. In January 2005, he was also appointed as Commander, Joint Functional Component Command for Integrated Missile Defense. He previously served as the Commanding General of the US Army Aviation and Missile Command and as the Director, Joint Theater Air and Missile Defense Organization. Lt Gen Dodgen held various command and staff positions in Air Defense Artillery and was a nuclear, biological, and chemical analyst and later chief of the Studies Branch at the US Army Chemical School, Fort McClellan, Alabama. He holds a bachelor's degree in chemical engineering, a master's degree in public administration from the University of Missouri and a master's degree in national security and strategy from the US Naval War College.

This is Not Your Father's US Strategic Command

Maj Gen William L. Shelton
Commander, 14th Air Force

Much has changed in the Department of Defense (DoD) over the last few years. Organizations have changed, missions have been reassigned, and many non-traditional assignments were developed. While the entire department has been changing, it would be hard for any DoD organization to top US Strategic Command (USSTRATCOM) for pace and magnitude of change.

The evolution of the old USSTRATCOM to the current organization began in 2002, when the President signed the Unified Command Plan (UCP). The UCP directed the combination of the previous US Space Command with USSTRATCOM to produce what was in reality, if not in name, a new command. The new USSTRATCOM was intended to synergize the best of both previous commands to yield a flexible, globally focused command with a disciplined planning underpinning. Even though this certainly was a large change in the US military command structure, the changes were not yet complete.

Change one to the 2002 UCP assigned four previously unassigned missions to USSTRATCOM: global strike, integrated missile defense, information operations, and C4ISR (command and control, computers, communications, intelligence, surveillance, and reconnaissance). When you add space operations to that list, that's a total of five new missions the command needed to assimilate—and in short order. To speed up the process, in the spring 2003, the command headquarters (HQ) staff reorganized into a unique functional structure, a departure from the traditional Napoleonic J-code model. With no additional resources and five new missions to address, this new approach was necessary to ensure progress.

General James E. Cartwright assumed command of USSTRATCOM in the summer 2004. The new commander realized that further progress on these broad new missions would require access to skills, resources, and authorities that were not resident at USSTRATCOM—and it was unlikely he could build adequate capabilities in the headquarters without creating a large, unwieldy staff. As a result, he turned to a novel construct of functional component commands.

Regional combatant commands use a time-honored, combat-proven command and control construct, with component commands organized by the various mediums of warfare (e.g., land, maritime, air). The joint activity levels of these regional components typically ebb and flow along with the parent combatant commands' participation in exercises and real-world operations. But for USSTRATCOM, with global missions that transcend the various mediums, the traditional component structure is inadequate. Because several of the missions have continuous operational activity, the typical "episodic" design would not be appropriate.

For these reasons, General Cartwright elected to establish four standing Joint Functional Component Commands (JFCCs): Space and Global Strike; integrated missile defense; intelligence, surveillance and reconnaissance; and Network Warfare. Organizing in this fashion allows access to skills already resident in the Services and agencies, thereby leveraging resources and authorities beyond the inherent levels at USSTRATCOM. Each of the components are commanded by a three-star general or admiral, with deputies from a different Service, and a chief of staff from a third Service—thereby creating the joint "triangle" at the leadership level. The manpower billets for the components are joint billets produced by ongoing reductions to the headquarters staff.

The JFCCs are activating and assuming responsibilities as quickly as manpower transfers and organizational maturity will allow. Eventually, the lion's share of USSTRATCOM's planning and operational activity will occur in these component commands. As directed by the Commander, USSTRATCOM, courses of action will be developed in the individual JFCCs, with extensive coordination and collaboration among them. The JFCC-Space and Global Strike will act as the integrator among the four components, synchronizing the best of all recommendations from the JFCCs for presentation to the commander for his decision. When the information technology systems are capable, the intent is for the JFCCs to act in a distributed, collaborative fashion, using parallel processes rather than the traditional serial staffing patterns.

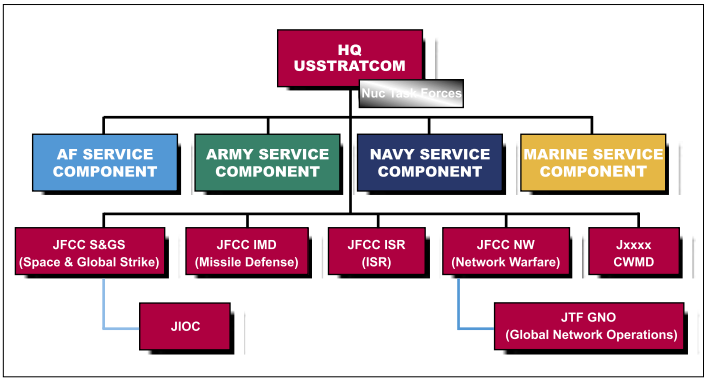


Figure 1.

In addition to the functional components, there are four Service components (Army, Navy, Air Force, and Marines), providing the Commander, USSTRATCOM ready access to the capabilities of each Service (figure 1). The JFCCs represent the vast majority of the capability needed to address the missions of the command, but continuing access to entire range of the

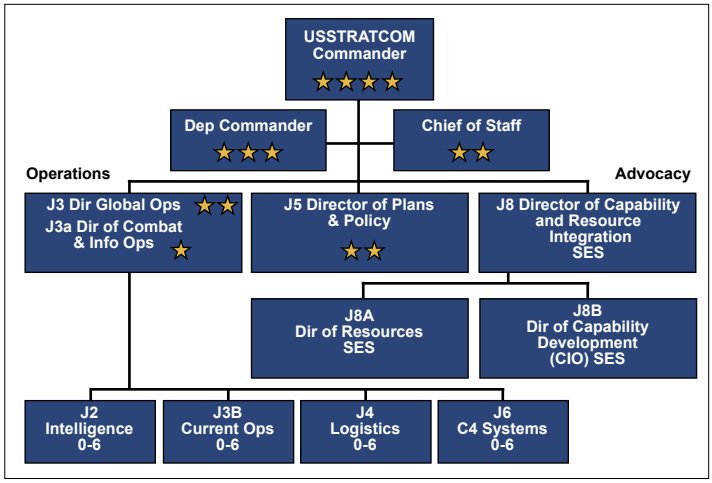


Figure 2.

Services' expertise through dedicated components is a valuable commodity.

To better support the new component organizational concept, the USSTRATCOM HQ staff reorganized to the J-code structure in the Fall of 2004. The staff structure consists of only three principal directorates: Operations (J3), Plans and Policy (J5), and Capabilities and Resource Integration (J8) (figure 2). Other traditional J-code functions exist, but not as separate directorates (e.g., J1 reports to the Chief of Staff; J2, J4 and J6 report to the J3).

The USSTRATCOM HQ retains nuclear command and control responsibility, and has four principal functions distinct from the JFCCs: strategic guidance, strategic-level integration and synchronization of plans across the command, global command and control, and advocacy. The first three responsibilities are somewhat self-explanatory, but the fourth deserves amplification. In recent years, changes to the joint requirements process give combatant commanders much greater responsibility for defining the capabilities needed for joint warfare. Advocating for these new capabilities across a very broad mission set is a challenge for USSTRATCOM. However, the powerful leverage available in the component commands provides tremendous expertise and insight.

As an example of how the advocacy process might work, let's examine how USSTRATCOM could advocate for space capabilities needed by the joint warfighter. The Space and Global Strike (S&GS) Component will be best positioned to have comprehensive insight into space capability shortfalls of the joint force. As S&GS identifies these shortfalls, they will work with the USSTRATCOM J8 staff to refine and present these capability shortfalls to the Joint Staff for eventual adjudication by the Joint Requirements Oversight Council. Many intervening steps in this process have been omitted for brevity, but the general concept is that JFCCs will work with the USSTRATCOM staff to jointly advocate for needed capabilities. Service components play a crucial role as well. They will be a strong voice in the shortfall definition, plus, in their organize, train and equip role, the Services will fund and develop the validated joint capability needs.

Obviously, this is a very busy time at USSTRATCOM. Changing organizational structures and added missions require substantial time and resource investments--and the changes continue. The Secretary of Defense recently assigned USSTRATCOM the mission of integrating and synchronizing DoD's efforts on Combating Weapons of Mass Destruction. At this writing, the Mission Analysis and Commander's Estimate work for this new mission was well underway. In concert with our partner in this endeavor, the Defense Threat Reduction Agency, we are taking the initial steps to embrace this complex mission. Much work remains.

In summary, USSTRATCOM has changed significantly during the past three years. The command has transformed from an organization focused solely on nuclear planning and operations to a global combatant command with many missions that are critical to national security. Even though your father may not recognize this new USSTRATCOM, the breadth and depth of the work at the command make it a challenging and rewarding place to work. Anyone looking to expand their horizons while gaining joint experience would find a good home at USSTRATCOM.

Maj Gen William L. Shelton is Commander, 14th Air Force, Vandenberg AFB, California. The 14th Air Force, the historic "Flying Tigers," is responsible for all US Air Force space forces and operations, including missile warning, space superiority, space-based surveillance, navigation and communications, satellite control and space launch, as well as the execution of assigned US Strategic Command's space operations.
General Shelton entered the Air Force in 1976 as a graduate of the US Air Force Academy. He has served in various assignments, including research and development testing, space operations and staff work. The general has commanded at the squadron, group and wing levels, and served on the staffs at major command headquarters, Air Force headquarters and the Office of the Secretary of Defense. Prior to assuming his current position, General Shelton was the Director of Plans and Policy, US Strategic Command, Offutt Air Force Base, Nebraska.

Bringing Space to the Fight: The Senior Space Officer in Operation IRAQI FREEDOM

Brig Gen Larry D. James
Vice Commander, Space and Missile Systems Center

The Battlecab at Prince Sultan Air Base, Saudi Arabia, was tense on the night of 21 March 2003 as all eyes peered into a multitude of computer screens and television sets, watching the most complex air campaign ever devised unfold. Air tracks on the large screens in the Combined Air Operations Center (CAOC) told an amazing story—hundreds of aircraft in the air, executing to perfection the Air Tasking Order that had been months in the making. Fighters, bombers, tankers, AWACS, electronic warfare aircraft and unmanned aerial vehicles were all being orchestrated from the CAOC—delivering critical blows that ultimately led to the end of the Saddam Hussein regime. But flying high above were systems just as critical to warfighting success—the space systems of Air Force Space Command (AFSPC) and the National Reconnaissance Office (NRO). Precision navigation, timely weather data, critical missile warning and infrared information, surveillance and reconnaissance, and tremendous communications capabilities—all came from our on-orbit systems that provided warfighting capability in this war like no war ever before. In fact, without our space capabilities, the air campaign that unfolded on this night could not have happened—space was not just an enabler but a key warfighting element of the total campaign. Behind the systems were the men and women of AFSPC and the NRO, executing operations around the world to ensure these capabilities were provided throughout Operation IRAQI FREEDOM (OIF). As the Senior Space Officer in the CAOC, I had the honor of representing our space warfighters and ensuring that the Combined Forces Air Component Commander, Lt Gen "Buzz" Moseley, received the space capabilities required to execute the mission. But there was a great deal of training and effort that led to this night and the follow-on execution of the war. My direct involvement began in November 2002.

The Combined Air Operations Center (CAOC), Prince Sultan Air Base, Saudi Arabia.

Preparation

As the world watched the situation in Iraq unfold in the fall of 2002, plans were being developed and practiced to execute air operations in Iraq if the President directed. This culminated in Exercise Internal Look 2002, conducted by US Central Command Air Forces (USCENTAF) at Shaw Air Force Base, South Carolina, in November 2002. This exercise brought together the CAOC team that would go forward into theater to execute Operation IRAQI FREEDOM. I reported Thanksgiving weekend along with my deputy Maj Mark "Gas" Main. The following three weeks were critical in developing relationships, refining tactics, techniques and procedures, exercising reachback to 14th Air Force (14 AF), and starting to define the role of the senior space officer (SSO). The existing CONOPS at the time did not have the role of the Senior Space Officer (now titled the Director of Space Forces) well defined, and a great deal of time was spent hammering out roles and responsibilities between the SSO, the senior staff, and the space personnel located throughout the CAOC. While everything was not fully defined by the time we finished the exercise, the time spent together paid tremendous dividends in allowing us to spin up quickly once we arrived in theater.

In-Theater Operations—pre-OIF

The CAOC team that had exercised together in November and December 2002 was directed into theater in late February 2003. We were in place about a month before OIF combat operations kicked off. Prior to OIF, a great deal of time was spent in three key areas—defining the relationship between the combined force air component commander (CFACC)/SSO and US Central Command (USCENTCOM), ensuring missile warning capabilities and addressing potential Iraqi Global Positioning System (GPS) jamming capabilities.

CFACC/SSO—CENTCOM Relationship

Joint Pub 3-14, Joint Doctrine for Space Operations, calls for the joint force commander to designate a single authority to coordinate joint space operations. Our belief was that this authority should be given to the CFACC since they had the preponderance of forces to be tasked, and the command and control capabilities, through 14 AF, for space forces. This position was not initially accepted by the Space Cell at CENTCOM Joint Space Operations Center (JSOC), and significant time was spent sorting through our recommendation. During this process, multiple direct liaison authorized (DIRLAUTH) relationships and multiple, sometime conflicting, requests for space support were competing at the 14 AF JSOC. Without a designated Space Coordination Authority in theater, these conflicts were becoming problematic. On 18 March 2003, CENTCOM issued a fragmentary order (FRAGO) designating the CFACC

Inside the CAOC, Prince Sultan Air Base, Saudi Arabia.

as the Space Coordinating Authority, one day before the air campaign kicked off. On 22 March 2003, the CFACC released a CONOPS to the theater components, detailing procedures for component requests for space effects. These would stay in place and be refined throughout the war. Certainly a key lesson learned was to define and implement these relationships well before combat operations begin, and then exercise them during peacetime to ensure the CONOPS are fully integrated.

Missile Warning Capabilities

A key concern prior to execution of combat operations was ensuring effective and timely missile warning throughout theater. The two key issues were (1) developing a robust detection capability and (2) ensuring the ability to get missile warning throughout the theater. We believed there was a SCUD threat, as well as threats from smaller missiles (Ababil 100s, for example), we needed a robust detection network that included space-based, airborne, ground-based and sea-based sensors. Setting all these sensors in place, and then linked into the CAOC, proved to be a challenging endeavor. With different sensor capabilities, different communications links and different reporting screens on the CAOC computer system, the officers in the Space Cell worked right up to the start of combat operations to bring all of this together. Their innovation and persistence paid off, and we were extremely successful in detecting 26 rocket launches from Iraq against coalition positions. The second challenge, providing this missile warning throughout theater, was a key concern of the CFACC. We needed to ensure that any coalition member in harms way received timely notification of a missile launch. Again, the Space Cell came through, working closely with the A6 (staff director for communications) to put into place all of the communications links and procedures which ensured near real-time missile warning notification throughout the theater. Our key lesson learned was the need to develop a robust missile warning architecture, including non-space assets, and a communications plan well before combat operations commenced, and then exercise those capabilities thoroughly.

GPS Jamming

Prior to combat operations, intelligence indicated that the Iraqis might have a GPS jamming capability. With the reliance on GPS guidance for our precision munitions, this led us to conduct a detailed assessment of possible impacts of GPS jamming. Reachback to 14 AF was invaluable in this effort as they and their contractor team provided the GPS Interference and Navigation Tool (GIANT), which allowed us to assess possible GPS jamming effects on different weapons and different weapon platforms. Based on this assessment, we believed that impacts would be minimal to our weapon accuracy. We also developed techniques to locate the jammers if they did turn on and used those techniques very successfully during the war to target the jammers.

Combat Operations

When the air campaign kicked off on 21 March 2003, our space capabilities were ready. Prior to the start of combat operations, the 2^{d} Space Operations Squadron (2 SOPS) at the 50th Space Wing, Schriever AFB, Colorado, had been directed by the CFACC to implement the GPS Enhanced Theater Support (GETS) technique. This capability ensures the best possible accuracy for GPS by uploading the latest clock and ephemeris data into the satellites as they come in view of the theater. The experts at 2^{d} Space Operations Squadron had improved the GPS GETS technique to allow continuous accuracy improvement for an indefinite period. They kept GETS implemented throughout the duration of major combat operations. General Moseley often briefed GPS accuracy performance to General Tommy Franks during daily update VTCs with CENTCOM, highlighting the criticality of this capability. Throughout the war, we maintained superb GPS accuracies, often seeing errors of less than two meters.

Our missile warning sensors and communications also performed superbly. Shortly after combat operations began, Iraqi forces launched multiple attacks with short-range ballistic missiles (SRBMs) from southern Iraq into Kuwait. Our sensors detected and provided warning for these launches. The true workhorse turned out to be a Navy Aegis Cruiser which was anchored in the Persian Gulf. Due to its proximity and effective radar, many of the SRBMs were first detected by the Aegis and warning given well within established timelines. The Defense Support Program (DSP) satellites were also key to locating a downed aircraft for search and rescue (SAR) forces. A coalition aircraft had gone down, and initial observer reports placed its location inside Iraq. However, based on DSP data and quick analysis by the Fusion Center at Schriever AFB, Colorado, we were able to direct the SAR forces to the actual location outside Iraq, thus reducing risk to our SAR personnel.

Military satellite communications (Milsatcom) was truly a workhorse for this war. You cannot execute the American way of war without rapid communications, and the CAOC relied on gigabytes of data flowing in and out of the center. Bandwidth was increased by about 600 percent over pre-OIF operations to support daily operations. Defense Satellite Communications System (DSCS) satellites were repositioned to provide two prime and three residual satellites coverage of the region. As a result, they were able to boost the capability to approximately 700 Mbps in the region and carry 80 percent of theater traffic. Also MILSTAR, with upgraded capability to securely transmit

an air tasking order (ATO) in six seconds rather than an hour as was previously needed, provided tremendous capabilities that allowed us to execute agile, responsive air operations as the threat and targets changed. In addition, the Global Broadcast Service (GBS) provided more than 350 Mbps of worldwide throughput and directly contributed to combat operations by supplying 1.25 Terabytes per day of very large data files and video streams, especially unmanned aerial vehicle (UAV) video, to the CENTCOM area of responsibility. Oftentimes, combat units (especially Navy special operations forces) established their GBS communications capabilities as soon as they encamped and were receiving current intelligence, imagery products, and multiple video broadcasts within a matter of minutes. A great example of the capability enabled by Milsatcom was the attack against Saddam Hussein in the Manseur district of Baghdad. Based on intelligence, his location was identified. Upon receiving approval to strike from CENTCOM, the CAOC Time Sensitive Targeting cell communicated with a B-1B bomber via Milsatcom and directed it to the target, also communicating the GPS coordinates of the target. The B-1B crew then input the coordinates into their Joint Direct Attack Munition and struck the target only minutes after receiving the go-ahead. As we continue to improve our links from sensor to shooter, these timelines will shorten even more, and space will be a key enabler of this capability.

Common "Space" Picture

During combat operations, operators in the CAOC could call up various displays on their computers and get near real-time information on the location of aircraft, ships, and ground forces. The space community did not have a corresponding system. We relied on reach-back to 14 AF to ensure we had the latest information, but only had a 14 AF briefing accessible via SIPRNET to get space status information in the CAOC. Another key lesson learned is that we need to move our space status and reporting capabilities up to par with the air, land, and sea forces. We need the ability to get near real-time status information on all our space systems, conduct analysis of coverage and capabilities, and have a complete picture of location and status of adversary systems. The Single Integrated Space Picture (SISP), being championed by 14 AF and HQ AFSPC, will go a long way in addressing this shortfall.

Conclusion

While many have said that Operation DESERT STORM was the first "Space War," I would argue that OIF was the first time we saw the true power of space capabilities to shape the battlefield, execute combat ops, provide precision and agility, and ensure success. Former Secretary of the Air Force James G. Roche stated that "For the first time in our history, space has become an equal partner to air-breathers," and this is absolutely true.[1] We learned many lessons from OIF, and AFSPC is focused on implementing those lessons so we are ready for the next war. We have integrated the Space Coordination Authority and Director of Space Forces concepts into our training and exercises with other combatant commanders, so we don't have to define these relationships on the fly in the future. We are improving GPS to make it more jam resistant. We are expanding our Milsatcom capabilities with Wideband Gapfiller and Advanced EHF satellites to be launched soon. We are addressing the CONOPS for missile warning and how we link multiple systems together. We are developing the Single Integrated Space Picture and have exercised with it in the Joint Expeditionary Force Experiment (JEFX). Our bottom line is that we can not rest on the successes of the last war. Our adversaries will learn their lessons just as we have, and we must continue to improve our systems, our CONOPS, and our training to ensure that we are the superior space force, whenever our Nation calls.

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General James entered the Air Force as a distinguished graduate of the US Air Force Academy in 1978. His career has spanned a wide variety of space operations and acquisition assignments, including space shuttle payload specialist, Air Staff program element monitor, Global Positioning System satellite program manager and Chief of Operations, 14th Air Force.

General James has commanded the 45th Spacecraft Operations Squadron, 5th Space Launch Squadron, 614th Space Operations Group and 50th Space Wing. He has served on the staffs of Headquarters US Air Force, US Space Command, and Air Force Space Command. He also served as the Senior Space Officer for Operation IRAQI FREEDOM at Prince Sultan Air Base, Saudi Arabia. Prior to his current assignment, the general was Assistant Director of Air and Space Operations, Headquarters Air Force Space Command, Peterson AFB, Colorado.

Notes:

[1] Dr. James G. Roche, Secretary of the Air Force. Address. 19th National Space Symposium, Colorado Springs, 9 April 2003.

Integrating Space Capabilities in Support of the USCENTCOM Theater of War A Challenge for the DIRSPACEFOR

Col Michael J. Carey
90th Space Wing Commander

Serving as the Joint Director of Space Forces (DIRSPACEFOR) for the Combined Force Air Component Commander (CFACC), US Central Command (USCENTCOM) is a dynamic and challenge task: directing without command authority, integrating capabilities from space- and terrestrially-based platforms in support of dispersed land force operations, and discerning space requirements from the various activities of the supported commands. The unclear scope of authority and lack of integration of space forces limit the DIRSPACEFOR's effectiveness. My deployed experience as the DIRSPACEFOR for the CENTCOM CFACC will serve as the context to describe these challenges and efforts to meet them with fruitful resolution.

Fallujah, Iraq

I arrived at Al Udeid Air Base (AB), Qatar, three weeks prior to the Battle for Fallujah, designated Operation AL FAJR, and served through the historic Inauguration of Afghan President Karzai, and the Iraqi National Elections. Plans were already mature for Operation AL FAJR. I assisted where I could, and determined how we could improve the integration and tactical application of space. Operation AL FAJR provided me a first hand ability to observe space capabilities being planned for and integrated into major combat operations, and I learned we had opportunities for improvement.

One of the planning factors in conducting operations in Fallujah was the desire to minimize damage to the city and its citizens. We did this in large part through the use of precise attacks which were aided by Global Positioning System (GPS).[1] Additionally, we conducted electronic warfare to jam enemy communications in an effort to degrade hostile command and control capabilities.[2] I quickly recognized that in our efforts to deny the enemy access to communication systems, there was a significant potential for our electronic warfare (EW) efforts to negate our GPS signal which would consequently degrade our efforts for precise weapons employment. Without close coordination, we would fail to integrate the two efforts needed for success. Clearly, I was not the only one who could figure this out, and ultimately it was the efforts of many who led to its adequate and timely resolution. As the DIRSPACEFOR, I looked at the problem from a space perspective and the implications of our planned activity on Coalition space requirements. As the electronic warfare coordination cell (EWCC) was focused on jamming enemy signals, the planners were focused weaponeering to restrict damage in the city of Fallujah and its surrounding area. The intense focus of these separate cells precluded their close cooperation and integration.

I raised the question as to how we might mitigate the unintended consequence of denying GPS to our own forces and quickly received needed information from the Space Warfare Center and Air Warfare Center. My deputy, LTC Todd Day, dug deep into test reports, Weapons School Papers, and other available analysis to help better frame the problem. Based on this information and calling for additional coordination, the personnel at the combined air operations center (CAOC) in Qatar, along with planning cells aboard the USS John F. Kennedy (CV 67), at Headquarters, Multi-National Corps-Iraq (MNC-I), Camp Victory, Iraq, and the 1st Marine Expeditionary Force in Al Asad, Iraq, took appropriate and coordinated measures to both deny communications to the enemy while retaining our precision strike capability and enhanced navigation tools. Existing tactics, techniques, and procedures (TTPs), as well as expedient TTPs, were promulgated in time for application during the operation.

My ability to positively influence the course of events prior to Operation AL FAJR is an example of discerning warfighter space requirements, exercising multiple sources of authority, and working with others to integrate efforts at the right level – established the proper integration point for increased effectiveness.

Authority

Authority comes from a variety of sources, three of which are rank, position, and expertise. The key to success for a DIRSPACEFOR in the CAOC lies in bringing all three to bear when needed.

CV Bomb Loader

As a colonel, the authority vested in the rank ensures you are able, and expected to, interact routinely with rank-peers to make recommendations concerning proper action, command structures and application of air and space forces. Although many senior officers are aware of operational space capabilities and the vast force enhancement implications they proffer, it is not typically at the fore of their mind as they are wrestling with day-to-day decisions. The space officers resident in the CAOC are doing a fabulous job, but their rank dictates that they function at an echelon well below the decision making level of the CFACC. Until April 2004, when Col Terry Djuric reported in as the first DIRSPACEFOR at Al Udeid, AB, space was the only major force being employed in support of Operation IRAQI FREEDOM (OIF) and Operation ENDURING FREEDOM (OEF) not represented by a senior officer in the theater. Having a senior Air Force officer whose primary focus is ensuring the full force of US space capabilities is properly considered and brought to bear to support current conflict in CENTCOM's area of responsibility (AOR) is necessary and appropriate. Colonel Djuric and her successor, Col Steve Tanous, succeeded in building the foundation for space integration throughout CFACC planning efforts to identify and address space support requirements. Notably, they were responsible for creating and institutionalizing the Space Coordination Plan: the first tool which documents a methodical approach to ensure space capabilities are included in planning effort in the theater for operations below that of CENTCOM deliberate planning efforts.

The DIRSPACEFOR reports directly to the CFACC, assigned to its Special Staff as a US Central Command Air Forces (CENTAF) resource, and as such has a significant degree of positional authority. However, as an Air Force officer in an Air Force service billet, there is no inherent or implied authority over joint forces. Additionally, since the DIRSPACEFOR serves as an advisor to the CFACC, has no directive authority over the assigned Air Force space forces, to include space personnel assigned to the Operations Division within the CAOC. Under this construct, I had positional authority to bridge different cells and see into each activity but no authority to task them directly. This is how we came to identify conflicting efforts as mentioned in the Operation AL FAJR example. The fact that I was not in a joint billet was not an issue to personnel developing the strike and EW plans for operations in Fallujah, it was more of an issue with HQ CENTCOM personnel. Those deployed recognized the intent of the position is to assist the CFACC in execution of his duties as the Theater Space Coordinating Authority (SCA). The CFACC was assigned SCA by explicit orders from the Commander, CENTCOM. Nonetheless, the fact that I was seen as an Air Force advisor only to some created friction and detracted from timely coordination on some space issues which were relevant to accomplishing objectives set forth by the supported commander, General George W. Casey, Jr., commander, Multi-National Forces – Iraq (MNF-I). The CFACC, Lt Gen Walter E. Buchanan III, recognized this problem and directed I be named the Joint DIRSPACEFOR and directed measures be taken to formalize the position as a joint billet with a small staff, estimated initially at four personnel, to assist in the execution of his existing SCA duties under the Joint DIRSPACEFOR.

As the Joint DIRSPACEFOR, credibility as the resident space expert is immediately assumed by peers at the CAOC, and for that matter, throughout the CENTCOM AOR. But since I haven't been involved in theater air, land, and sea operations throughout my career it becomes clear I was on the working side of a steep learning curve and must invest energy in learning the vernacular, operations, force structure, relevant terrain, et cetera. It is within this context that space operations must be applied to become tactically relevant. As stated earlier, while viewing the mission objectives of Operation AL FAJR from a space perspective, I was able to readily identify the potentially conflicting nature of ensure precise navigation and timing signals while denying communication capabilities to the enemy. Other experts, once made aware of the problem were fully able to remedy the problem.

It was apparent to me that when expert authority was not indigenous to the CAOC staff, it was hired. We did that throughout the CAOC's organization of cells, special staff and liaison officers. For example, when we employ EA-6Bs or EC-130s, we have an expert from that weapon platform attached to the COAC organization to ensure its capabilities and limitations are understood and integrated optimally. The same is true for any air weapon system. The difference between space systems and air systems is that air systems are more widely understood, in general, so planners and operators know to ask for expert help. I found that there was still a general lack of knowledge regarding space systems and their capabilities amongst the personnel throughout the CENTCOM AOR; hence they often didn't even know to ask pertinent questions. Because of this, as I traveled to various units to better understand their missions and tasks in an effort to further discern and refine their space requirements. Combined Joint Special Operations Task Force – Arabian Peninsula (CJOSTF-AP), Iraq, for example, briefed me on the details of a mission and it was clear that space could play a bigger role for this organization than it currently was. Due to the lack of common understanding of space capabilities, these forces were accepting unidentified risk.

Unidentified risk is not the same as unnecessary risk. Once a commander is made aware that a risk can be reduced, they must

determine whether or not it is worth mitigating – what are the pros and cons. Perhaps the risk I identified was necessary, but it was clear during our conversations it had been a previously unidentified risk which needed to be addressed. The challenge quickly became one of expert authority and integration. At this point, I no longer had the expertise to conduct the mission area analysis to discern capabilities and limitations of space systems in support of a specific mission type, so I asked the CFACC for support and he hired it. The CAOC now has the appropriate resident expertise to perform the necessary mission area analysis. How to integrate the new talent into the CAOC and how to integrate the system capabilities into the fight became the next hurdle.

Integration

In order to be effective at bringing various and disparate systems, people and information together in an effective way requires one to understand the various means to integrate in the first place. While assigned to the Space Warfare Center in 2003, I was given a task to determine how we could integrate warfare centers in the Air Force. I concluded that there were five ways to integrate: (1) look the same, (2) cross-flow personnel, (3) organize similarly, (4) develop interoperable systems, and (5) integrate functions at appropriate echelons. Most of these are very familiar to us because we see it throughout the Air Force all the time. Each of the five methods of integration could fill volumes exploring opportunities and challenges; I have cited only a few for illustrative purposes.

1. Look the same: In an effort to integrate people from all walks of life into an effective fighting organization, we dress within certain codes and wear common uniforms. In CENTAF, for example, regardless of your home unit, when you deploy forward, you wear desert uniforms with a CENTAF patch – not your Air Force Space Command patch. While I was stationed at Al Udeid AB, Qatar, I even saw foreign officers working in the CAOC procure US-style flight suits so they also would "integrate" better. It was clearly their attempt to fundamentally and visibly integrate more effectively...and it worked.
2. Cross-flow of personnel: To better understand our counterparts' missions, capabilities and limitations, we often provide liaison officers between organizations. This allows "one of ours" to help communicate between commands, bringing both units to a more full estimation of the situation at hand. This technique of integration was in full swing at the CAOC and established in doctrine and policy resulting in the positions such as the naval air liaison element (NALE) and special operations liaison element (SOLE) to name two of many. There were ad hoc cross flows as well. We flowed numerous people up to Baghdad, Iraq and Bagram, Afghanistan in order to better understand specific missions, capabilities, and limitations. An important point to remember is that the DIRSPACEFOR is not a liaison officer to the CFACC. The DIRSPACEFOR is on the CFACC's staff providing advice to and receiving guidance from the CFACC. There is no US Strategic Command or Air Force Space Command liaison officer in the CAOC, nor is there a CFACC liaison officer in either of those two commands. This is a potential issue when we are relying on significant reach back. What I found was, most often, you had to be in the room at the time of the discussion to have your voice heard and to receive critical information. Cross-flow facilitates the interpersonal part of integration like no other.
3. Organize similarly: Another means to increase effective integration is to organize similarly between different organizations. We are familiar with tactical organizations having a training shop, and tactics shop, a personnel flight, et cetera, and as such we know where to direct our questions, taskings and other communiqués because of the similarity. Familiar office symbols and "J-codes" ease the ever-challenging requirement to communicate quickly and effectively. Difficulty arises when new, non-standard, and dissimilar organizations are created. Although there may be logic in the new organization, it is not intuitively obvious to the uninitiated as to where they should direct their communications to get a job done. This element of integration reinforces the belief that space experts need to be integrated into existing CAOC cells and not be formed into stand-alone space cell resulting in a non-standard CAOC structure. It is important to remember that there are other several CAOCs around the world.
4. System to system integration and compatibility: Although the details here get classified rather quickly, suffice it to say that issues such as integrating blue force tracking (BFT) data aboard airborne platforms have to contend with data latency issues in order to correlate BFT data and other data for force protection. As we continue to increase both the number of systems we employ in the field and the desire for machine to machine information transfer in an effort to gain ever more speedy situational awareness, the challenge for such system integration becomes a routine concern and challenge, and the CAOC is no-different.
5. Integrate functions at appropriate echelons: Establishing the proper integration point is one of the easiest integration functions to implement, yet most likely the most emotional one to overcome. It is difficult because it requires people and organizations to change the way they currently do business, and one or more entities usually ends up with a diminished role in decision-making for the greater-good of the larger element. In order to properly integrate units they must first have similar missions, similar internal organizational structures, and similar guidance (e.g., Air Force Instructions). Ensuring that newly assigned forces are attached to the proper organizational echelon for optimal integration and command and control is an on-going process.

As the DIRSPACEFOR, the task of integrating space capabilities without the benefit of established protocols required personal presence and cognizance of a vast array of potential space applications. Currently, traditional space-based force enhancement capabilities are well integrated and the personnel at the

CAOC are well ingrained in the system. However, opportunities were being missed and risk incurred due to a lack of space control expertise in the AOR. The CFACC has the responsibility to gain and maintain both air and space superiority – he must assure it, not assume it. The vast majority of space capability brought to bear in theater is best leveraged through reach-back of non-AOR assets. To do the space part of his mission the CFACC must have personnel proximate to the war participate in the developing combat environments of Iraq and Afghanistan, as well as the significant areas of effort throughout the AOR (e.g., Horn of Africa). Since the CFACC knew they didn't have the resources or the capability to establish space superiority alone, they wanted a single point of theater focused expertise to work with.

The CFACC addressed this challenge by establishing a Joint Space Integration Cell (JSIC): a small pool of space experts tasked to perform mission area analysis and draft COAs to develop relevant theater space-related situational awareness, protect his critical satellite communication links, and if appropriate and authorized deny the same to an adversary thus assuring space control. They will be key to synchronizing the efforts of reach back capabilities and developing a potential theater source for a greater single integrated space picture.

My four-month deployment provided me a career-unique opportunity to serve with remarkable warfighters from around the world. In particular the two Army space officers who served as my deputies, first LTC Todd Day and later LTC Sandy Yanna, were invaluable in developing the DIRSPACEFOR role and executing the CFACC SCA role. They are exceptionally talented officers, who truly understand the joint nature of space and its critical application to enhance both the safety and lethality of coalition forces.

Our US and Coalition forces are nothing short of outstanding men and women. They represent not only a willing, but exceptionally capable, force fighting to bring peace and stability to Iraq and Afghanistan. Serving through such an historic period, with the task to mature the DIRSPACEFOR role during combat operations was a daunting and rewarding experience. It was an honor to join the cadre of space professionals that continue to better integrate space operations throughout our joint and combined forces. Through their daily engagement in normal CAOC functions, US space capabilities provide critical space support to on-going operations and make space more tactically relevant to the supported commanders.

Notes:

[1] Lieutenant General Thomas Metz, Commander, Multinational Corps-Iraq, US DOD/OSD-PA News Transcript of Special Defense Department Video Teleconference Briefing, 9 November, 2004, on-line, Internet, available from http://www.defenselink.mil/transcripts/2004/tr20041109-1561.html; "The fight in Fallujah is far from over. We are proceeding with speed, not haste, to maintain the initiative, and we are using caution and precision in order to minimize civilian casualties and damage to the city." Metz.

[2] Ibid., "We are working hard to impact his command-and-control capabilities in mainly electronic warfare jamming and those things that keeps him -- causes him to have a harder time to communicate." Metz.

Colonel Michael J. Carey is the commander, 90th Space Wing, Francis E. Warren Air Force Base, Wyoming. He directs the wings operation and maintenance, including 150 Minuteman III and 4 Peacekeeper intercontinental ballistic missiles deployed over a three-state, 12,600 square mile area.

Colonel Carey enlisted in the Air Force in 1978 serving as an avionics technician on F-4D fighters, and was later commissioned through the Reserve Officer Training Corps in 1983 at the University of Central Florida. He has operated the 5D-2 DMSP weather satellite, AN/GPS-10 space surveillance radar, Atlas I/II/IIA rockets, Colorado Tracking Station, the Minuteman III ICBM, and Red Bear and Red Owl GPS jammers. He served as Politico-Military Affairs Officer and executive officer, for the Deputy Chief of Staff for Plans, and Aide to the Commander, Headquarters Air Force Space Command; in Washington, D.C., he served on the Air Staff as the first Information Warfare Joint Warfighting Capabilities Assessment Integrator, and the first Space Operations Planner, for the Directorate for Force Structure, Resources and Assessment, on the Joint Staff. He also served as the Director of Space Forces, Combined Air Operations Center, Al Udeid, Air Base, Qatar. His previous commands include: Detachment 7, 750th Space Group, Falcon AFB, Colorado. and the 321st Missile Squadron, F.E. Warren AFB, Wyoming, and the 595th Space Group, Schriever AFB, Colorado. Prior to this assignment, Col Carey was the vice commander, 50th SW, Schriever AFB, Colorado.

Warfighting Needs and Uses for Responsive Space in the USPACOM Theater

Col Jeffrey Yuen, USAF
Deputy Commander, 502 Air Operations Group

"We are in a dynamic security environment, which must be met in new ways of commanding, equipping, employing, and stationing our forces. Fundamentally, long term peace and stability hinge on continued transformation of our military force posture, enduring relationships with our regional neighbors, and relevant, combat capability forward to ensure adequate dissuasion and deterrence of potential aggressors."

- Admiral William J. Fallon, Commander, US Pacific Command, Testimony to the Senate Armed Services Committee 8 March 2005

Stability in the Pacific is essential to the security and prosperity of the entire world. The Pacific region is home for roughly 60 percent of the world's population and in 2002, represented over 30 percent of the US trade, over 522 billion dollars. Given the importance of this region, United States Pacific Command (USPACOM) and Pacific Air Forces are faced with challenges integral to global security. Responsive space provides a concept to optimize the effects from above. As we develop the Responsive Space or Joint Warfighting Space (JWS) concept and capabilities, the effects from these platforms provide the Commander, United States Pacific Command (CDRUSPACOM) strengthened ability to dissuade, deter, and, if required, combat potential aggressors and de-stabilizing activity in the region. In today's uncertain security environment, we must realize our transformation efforts in order to provide flexible capabilities to meet dynamic needs.

Figure 1. Trade Routes in the Pacific Region.

Challenges In The Pacific

Asymmetrical threats such as piracy, drug trafficking, and terrorist activities, nations with intent on owning and exporting weapons of mass destruction, technological space peer, and the tyranny of distance, collectively present a great challenge to maintaining a secure and stable peace in the region.

Piracy. Southeast Asia shipping lanes are extensive (figure 1). Like the Panama Canal and the Suez Canal, the Strait of Malacca is one of the most important strategic passages of the World because it supports the bulk of the maritime trade between Europe and Pacific Asia. About 30 percent of the world's trade and 80 percent of Japan's imports of petroleum transits through the strait.[1] Last year, the International Maritime Bureau recorded 37 pirate attacks in the strait, despite coordinated patrols. Over the last decade, attacks on commercial ships in the Pacific have tripled. This rise in piracy is even more troubling when you consider, 90 percent of the world's trade moves via ship with almost half of all ships moving through Asian waters. As recently as 1999, nearly two-thirds of all pirate attacks occurred in Asia.

Weapons Proliferation and Drug Trafficking. The proliferation of Weapons of Mass Destruction as well as illicit drug trafficking through Pacific waterways are of grave concern. The State Department's top arms control official says North Korea is "the world's foremost proliferator of ballistic missiles and related technology to rogue states and hostile regimes" and Burma (US recognizes Burma, the name Myanmar is recognized by UN) is the world's second largest producer of opium. Greater proliferation threats may be just over the horizon. North Korea's highly enriched uranium program, along with its plutonium-reprocessing program, raises the specter of nuclear weapons as part of a proliferation-for-profit strategy as previously seen in Pakistan. In 2002, a disguised North Korean vessel surprised the world by delivering medium range ballistic missiles to Yemen. In 2003, the State Department said Taiwan interdicted "dangerous precursor chemicals" on their way to North Korea for use in its chemical-weapons program.

Terrorism. The threat of terrorism is widely dispersed throughout the Pacific. Terrorist groups spread throughout the

area of responsibility (AOR) to include Indonesia's Jemaah Islamiya (JI), and the Free Aceh Movement GAM, the Philippines' Abu Sayyaf, the Moro Islamic Liberation Front, the New Peoples Army, and the Liberation Tamil Tigers Elam operating in Sri Lanka. Additionally, Maoist insurgents operate in Nepal and others are known to be in Kashmir and southern Thailand.[2]

Space and Missile Capabilities. Over the years, China has developed space launch capabilities along with capabilities in satellite communication, navigation, earth monitoring, and remote sensing. The 1998 Report to Congress "Future Military Capabilities and Strategy of the People's Republic of China," states "China already may possess the capability to damage, under specific conditions, optical sensors on satellites. Given China's current interest in laser technology, it is reasonable to assume that Beijing would develop a weapon that could destroy satellites in the future."[3] The threat of missile attack to friendly nations is very real in the Pacific region. India's missile program is second only to China's in the developing world. India's rivalry with Pakistan has also precipitated an accelerating regional arms race in which both ballistic missiles and the two states' nuclear programs continue to grow. Both India and Pakistan also have interest in a submarine-launched ballistic missile (SLBM) capability as well as anti-satellite technology.[4] China's military, now considered large and fairly modern, poses a challenge in the event of a crisis. Chinese ballistic missile systems include mobile conventional/nuclear ballistic missiles, mobile Inter-Continental and SLBMs.[5] Furthermore, North Korea's military possesses Short and Medium Range Ballistic Missiles.

Environmental Consideration. With the Pacific region covering over 105 million square miles or 52 percent of the earths surface and over 60 million square miles of ocean, distance remains the number one challenge.[6] Even with the current bases like Andersen Air Force Base on Guam, and Diego Garcia, most of the Pacific cannot be easily reached by airborne assets. Most of Southeast Asia's landscape is covered by rainforests. Biomes in East China are much like those found in Europe with deciduous forests. The combination of forest biomes with heavy foliage and unfavorably wet weather is another challenge to finding and tracking those activities that are designed to disrupt regional stability. (figure 2)

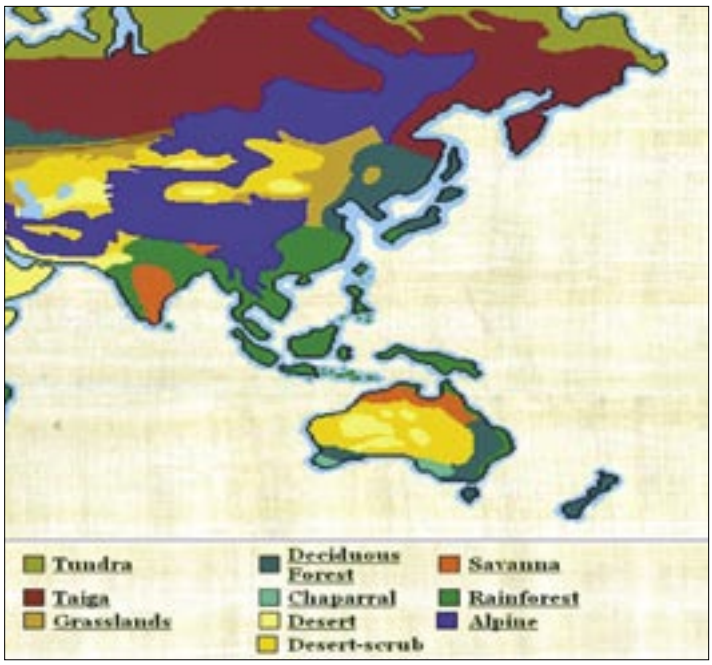

Figure 2. Topography in the Pacific.

Required Capabilities

The JWS concept centered on responsive space and near space (i.e., area above the earth from ~ 65,000 to 325,000 feet altitude, sub-orbital) capabilities can directly support CDRUSPACOM across the range of military operations. A sea or airborne launch on-demand, rapid reaction, capability would greatly enhance our ability to exploit the "vertical" medium to maintain stability in the region and combat potential adversaries. Fully integrated and synchronized with joint operations, JWS has the potential to provide CDRUSPACOM with unprecedented capability to exploit the high ground.

Effects from JWS. The ability to maintain persistent situation awareness of regional activity both on land and at sea is critical to maintaining stability in the region. Current airborne platforms such as the U-2, P-3, deployed Rivet Joint, Combat Sent, and Cobra Ball and National assets are suitable for maintaining the traditional indications and warning. Surveillance and tracking of de-stabilizing asymmetric activities such as piracy, terrorism, and weapons of mass destruction proliferation are absolutely essential to deterrence and dissuasion.

Although effective, airborne intelligence, surveillance, and reconnaissance (ISR) platforms are limited in its capability to provide persistence. Neither the 400nm reach of Predator, nor the 12,000nm reach of Global Hawk can provide the range and timely coverage provided by space-based assets.[7] JWS (low earth orbiting and near space) ISR platforms are ideal to overcome the distances and denied area access challenges in the Pacific. The planned tactical satellite (TacSat-1), a $15 million,

"China already may possess the capability to damage, under specific conditions, optical sensors on satellites. Given China's current interest in laser technology, it is reasonable to assume that Beijing would develop a weapon that could destroy satellites in the future."

- Report to Congress, 1998

132 kg, electro-optical and infrared satellite, is representative of the types of low cost ISR capability that can be rapidly deployed to fill seams in our ISR coverage. Synchronizing National assets with a responsively launched TacSat-like system and a Global Hawk could provide us the persistence to find and track moving targets during increased periods of tension. Tracking of moving targets over broad ocean areas and targets operating under or through foliage are essential to this region.

Blue force tracking and low probability of intercept communications enhanced by JWS capabilities are critical enablers. Given that the Pacific AOR covers over 105 million square miles, long haul, high bandwidth, secure, and reliable communications between land and sea based command elements are absolutely essential. Responsive JWS near space communications assets coupled with on-orbit ultrahigh frequency (UHF) follow-on satellite system (UFO), Defense Satellite Communications System (DSCS) and military strategic and tactical relay system (MILSTAR) capabilities can provide theater commanders sustained connectivity in times of crisis.

Space superiority cannot be assumed in this region. With recognized space powers located in the region and our reliance on space systems, our use of space will most likely be challenged in major regional conflict in the Pacific. Blinding us, silencing us, and disorienting us to achieve a level of surprise are effects an enemy can achieve if they are successful in denying our use of space. JWS can provide a defensive counterspace capability as adversaries seek active and passive methods to deny us use of our space assets. In the event of an attack on our space systems, JWS could provide a responsive replenishment capability. However, a JWS system that can provide indications and warning of a pending attack or a near-earth JWS system linked with a SATCOM Interference Response System (SIRS) to detect, characterize, and geo-locate electronic attacks on our space systems would provide an avenue for us to identify the aggressor and respond accordingly.

In a major regional conflict, denying the adversary the use of space is an option the joint force commander (JFC) must consider. A JWS capability, similar to the recent demonstration of autonomous rendezvous technology (DART) can be employed to characterize the operating parameters of a Low Earth Orbiting satellite. Designed to maneuver around the satellite as close as 15 feet, a DART-like JWS system could provide a precision attack capability to disrupt, degrade, or destroy an enemy combatant's space system. Employed with the ground-based Counter Communications System, the JFC could provide synchronized temporary, reversible effects to disrupt and deny an adversary's use of space-based command, control, communications, computers, and intelligence (C4I) systems.

Integrated Operations. As the JWS concept is envisioned to provide the JFC dedicated and responsive space capabilities, equally important is the capability to synchronize JWS effects. In the Pacific area of responsibility, the Pacific Air Operations Center (PAOC) is responsible for the operational-level command and control of air, space, and information operations (excluding the Korea Theater of Operations). To optimize effects from above, the PAOC, networked with FALCONER AOCs and Joint Space Operations Center and Vandenberg AFB California, must be manned and equipped to fully integrate JWS in its daily operations.

The PAOC has institutionalized the air tasking order (ATO) planning and execution cycle for daily air operations. Using a three-week planning cycle for a one-week execution period, the PAOC uses the ATO strategy-to-task construct to plan and task airborne ISR and other selected air operations. This focused approach to daily operations enables the PAOC to optimize employment of air assets to meet CDRUSPACOM's overall regional strategy and needs. JWS capabilities should be fully integrated in this planning and execution construct to reap its full effect. The active PAOC planning to synchronize JWS and airborne assets is crucial to our ability to optimize ISR assets to provide persistent awareness. Additionally, integrating JWS with airborne operations greatly improves our ability to locate, ID, track and, if necessary engage and assess targets in the vast expanses of the Pacific. (figures 3a, 3b) This seamless synchronization and integration of space and airborne assets was successfully executed in the recent RESULTANT FURY 04 demonstration where space assets were seamlessly linked with airborne platforms to find, fix, target, and destroy mobile

Figure 3a. Direct Hit on USS Schenectady (Large Sea Transport) in RESULTANT FURY 04.

Figure 3b. Damage to USS Schenectady (Large Sea Transport) in RESULTANT FURY 04.

maritime targets. The PAOC planners, intelligence experts, and operators were the centerpiece of developing and successfully executing the integrated plan. (figure 4)

Although RESULTANT FURY provided a successful vignette on the seamless employment of air and space assets, this fusing of effects would only be possible with space and air professionals operating side-by-side in the AOC divisions. To maximize the effects from JWS, the five FALCONER AOCs throughout the Air Force must include the expertise and systems to effectively plan and synchronize operations on a real-time, no-notice basis. Current Blue, Red, and Grey Space Order of Battle coupled with real-time notifications of New Foreign Launches and possible satellite maneuvers are essential to maintaining space situation awareness. Tools such as the Space and Missile Analysis Tools (SMAT) driven by current Element Sets providing real-time collection opportunities and overhead threat positional data are essential to AOC planning and synchronization of operations. Current and continuously updated intelligence on satellite operating parameters such as commanding patterns and sequences, location of command and control sites and data downlink stations, satellite signal structure, and known users, location of threat systems to our use of space assets are essential to real-time integrated planning and execution. Fusing this information with theater battle management core system (TBMCS) and future theater battle operations net-centric environment (TBONE) and networked with the Joint Space Operations Center, the AOCs would provide the Joint Force and Air Component Commanders a powerful capability to control and exploit the high ground.

Way Ahead

JWS provides a concept that will provide the combatant commander a responsive space capability to meet security challenges of the future. As with other combatant commands, PACOM must continuously dissuade and deter potential aggressors in the region. JWS, designed to meet the unique challenges of the Pacific, integrated with airborne assets will certainly improve our capability to meet those objectives. The transformations we institutionalize with JWS will empower the combatant commander with on-demand global awareness and, in the future, Global Strike capabilities.

Notes:

[1] Dr. Jean-Paul Rodrigue, The Strategic Space of International Transportation, Transport Geography on the Web, chapter 5, on-line, Internet, 16 May 2005, available from www.people.hofstra.edu/geotrans/eng/ch5en/conc5en/ch5c1en.html.

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[3] Chinese Anti-Satellite [ASAT] Capabilities, on-line, Internet, 16 May 2005, available from www.globalsecurity.org/space/world/china/asat.htm.

[4] Central Intelligence Agency, *CIA World Fact Book,* (Potomac Books (May 27, 2005).

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Technologies Necessary to Make Warfighting Space a Reality

Col Rex R. Kiziah
Director, Space Vehicles, Air Force Research Laboratory

"We seek to foster a culture of innovation. The war on terrorism imparts an urgency to defense transformation; we must transform to win the war."

- The National Defense Strategy of the United States of America, March 2005

The 21st century has brought dramatic changes to our National Security environment. We have witnessed the end of Cold War military strategies that focused on engagement with a near peer in a well defined and understood theater of operations. The adversaries we face today can appear and disappear quickly. They can cross national boundaries and hide in remote parts of the earth. Rapid technology proliferation has given them global access to a wealth of information databases, communication systems, precision navigation systems, weather forecasting, and intelligence gathering systems without ever having devoted effort to their development, fielding, and operations. It has allowed them access to weapons of mass destruction previously available only to the wealthiest and established nations. This adversary seeks to employ irregular methods and disruptive capabilities to erode US military power and political influence. Uncertainty is the defining characteristic of today's strategic environment. While we work to avoid being surprised, we must posture ourselves to handle unanticipated problems.[1]

Space provides an important position from which to avoid surprise and space power represents a decisive, asymmetric advantage for the US.[2] Historically, space has been an expensive domain in which to operate and thus restricted to missions of the highest national priority by the world's wealthiest nations. However, technology proliferation has lowered the barrier to operating in space. More than forty countries have entered the space age in the last ten years, including India, Pakistan, Nigeria, Chile, Argentina, China, and Morocco.[3] The future actions of each of these nations in space are unknown. Yet, it is imperative for the future security of the United States that we maintain supremacy and freedom of action in space.

This freedom of action in space will enable us to identify, locate, track, and engage individual enemies and their networks around the globe. This will require greater capabilities in intelligence, surveillance, reconnaissance, and communications.[4] The risks of uncertainty and the potential for surprise will require warfighters that can respond and adapt quickly to an adversary's action. The space systems of the future must also be able to respond and adapt just as quickly to provide critical battlespace awareness to the warfighter.

Modular, Plug-and-Play, Reconfigurable Satellite Technologies

Space acquisition, however, has traditionally been an endeavor where long lead times are the rule and capabilities must be chosen decades in advance. Warehoused "copies" of single purpose spacecraft may enable rapid reconstitution and force projection, but this is an expensive approach that does not provide responsive adaptation to changing threats. To meet the goal of truly responsive capability, the Air Force Research Laboratory (AFRL) is investing in flexible solutions from modular plug-and-play components to reconfigurable structures, wires, and interfaces that will someday enable us to change "on the fly" a system's characteristics, and even its mission capabilities. AFRL is leading a national effort to develop plug-and-play interfaces for transfer of power and data in a spacecraft. These standards leverage commercial developments for personal computing such as Universal Serial Bus (USB), SpaceWire, and ethernet protocols. These efforts play a significant role in reducing the time necessary to assemble and integrate components. The ultimate goal is to be able to respond to a warfighter's request for tactical space support in less than six days, from mission call-up to data dissemination to the joint forces commander on the ground in the theater of operations. AFRL and the Office of Force Transformation (OFT) are developing an integrated responsive space test-bed for reconfigurable space system components that will demonstrate the rapid integration, test and check-out of payloads, buses, and launch vehicles in a laboratory environment.

Microprocessors such as Pentiums and PowerPCs are examples of reconfigurable systems, but these commercial systems cannot survive in the space radiation environment. Thus expensive, radiation-hardened versions of these chips are normally built in dedicated facilities. One innovative alternative approach is to introduce radiation hardening by design, yielding commercial chips from commercial facilities--chips that can function properly and survive for reasonable mission durations in the harsh space environment. Field Programmable Gate Arrays (FPGAs) are manufactured in the same fashion as microprocessor chips but are vastly more reconfigurable and capable than traditional processors and are rapidly finding applications in almost all aerospace systems. AFRL is working within the space electronics community to further the space worthiness of FPGAs and to infuse them into new responsive spacecraft bus architectures.

Reconfigurable space systems also require advances in structural, electrical, optical, mechanical, and fluid interfaces to form capable systems. AFRL and the Defense Advanced Research Projects Agency (DARPA) have developed standardized interfaces for the Orbital Express on-orbit servicing mission that will enable new spacecraft payloads, modules, and fuel to be added to a satellite in orbit. AFRL is also investing in modular and reconfigurable structures that range from apertures that can expand more than one-hundred times their stowed size to reconfigurable wiring harnesses imbedded into the structure that show promise to save five times the weight and volume of traditional wiring.

The demand for increasing power in space will continue at a rapid pace. AFRL has long been active in this area, and virtually

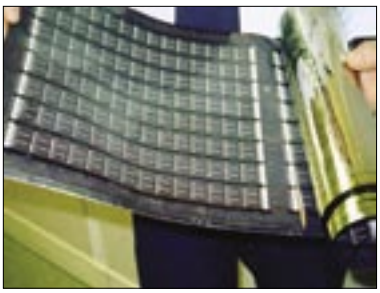
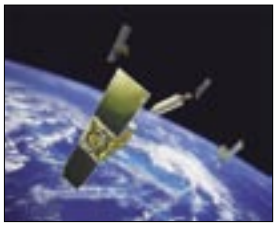


Figure 1. Thin Film Photovoltaic solar arrays show promise to provide megawatts of power for future spacecraft at one fifth the cost and weight of traditional crystalline solar cells.

every Department of Defense (DoD) spacecraft flying today uses AFRL-developed crystalline cell technology. AFRL is continuing to lead the development of crystalline, multi-junction solar cells, pushing the number of junctions to five with promise to achieve efficiencies greater than 35 percent by 2008. The spacecraft of the future, however, will require a different solar cell technology because of the large power needs estimated to be between 25 and 100 kilowatts (e.g., space radar). AFRL is leading the development of Thin Film Photovoltaic (TFPV) arrays, as shown in figure 1. Initially developed for the terrestrial market, AFRL is adapting this technology for space with a goal of a fivefold increase in the specific energy cost (watt per dollar) and a fivefold reduction in the specific energy density (watts per kilogram) compared to crystalline cell technology. While these arrays have lower efficiency, approximately 9 percent, compared with traditional crystalline cells, the ability to manufacture these materials in a roll-to-roll process reduces cost and increases packaging efficiency such that a very large array can be deployed from a small stowed package, providing hundreds of kilowatts of power at an affordable price, and an overall greatly reduced mass.

W. Hartenstein/Orbital Sciences Corporation

Figure 2. Launch of AFRL's XSS-11 Spacecraft from Vandenberg AFB on 11 April 2005. XSS-11 will demonstrate autonomous rendezvous and orbital navigation around another resident space object.



To reduce operating costs and increase efficiency and responsiveness, spacecraft of the future must take advantage of recent developments in autonomous operations. This will enable the logistics trail to be greatly reduced, saving significant costs, reducing operations time, increasing flexibility and reducing operational complexity for the user. AFRL's XSS-11 program developed autonomous mission planning and operations technologies that has reduced the number of people required to operate the spacecraft by more than half. This spacecraft launched on 11 April 2005 from Vandenberg AFB (see figure 2) and began initial on-orbit checkout and system functional tests in preparation for demonstrating the ability to autonomously conduct complex space operations with only top-level commands from the user. These technologies are key enablers for proximity operations in space, such as rendezvous, close inspection, docking, and servicing in which man-in-the-loop control takes much longer to execute due to ground-to-space latency. These technologies must be extended for future tactical spacecraft to enable fast response to rapidly changing threat conditions on the ground and in space.

Responsive Space Payloads

AFRL is also developing powerful new payloads that will offer unprecedented capabilities to the warfighter. Rapid advancements are being made in the development of low-cost electro-optical imaging systems, low-cost radar systems, light-weight deployable antennas, and low-cost hyperspectral imaging systems. Reducing the cost of these eyes, ears, links, and beacons will enable space-derived effects to be integrated across the battlefield. Research programs are underway that explore polarimetric and temporal phenomena to detect and characterize targets obscuring clouds, foliage, and even earth cover. Current surveillance systems are blind to these common backgrounds. The intelligent fusion of spectral, temporal, and polarimetric signatures will greatly enhance our capabilities to deny the enemy the ability to hide, camouflage, or make effective use of decoys anywhere in the world.

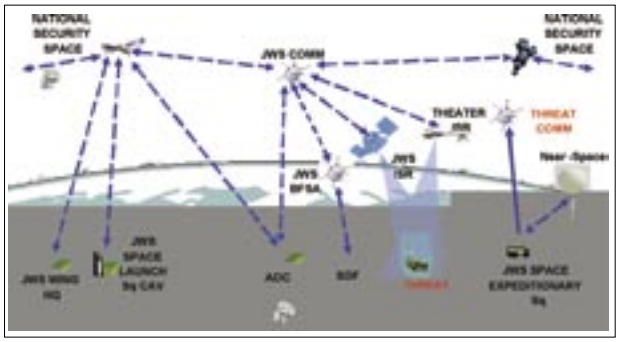


Figure 3. The Joint Warfighting Space (JWS) architecture consists of responsive launch, range, spacecraft and ground command, control, and data dissemination systems. These must be designed to increase warfighting capabilities and to reduce the associated cost and time.

Responsive Launch

While there is a need for payloads themselves to be responsive, nothing less than a complete end-to-end reengineering of the entire space system will meet future needs. Figure 3 highlights the broad system-of-systems nature of this problem. AFRL is working with DARPA and the Transformation Directorate at the Air Force Space and Missile Systems Center (SMC/TD) to develop and demonstrate a launch vehicle capable of delivering 500 kilograms to low Earth orbit (LEO) for $6 million within six days of mission need. The Force Application and Launch from CONUS Small Launch Vehicle (FALCON SLV) Program is focused on the launch vehicle development, and the Generic Application of Launch Technologies (GALT) Program is developing low-cost, responsive range safety systems. It is precisely this combination of affordable and responsive launch vehicles, and flexible, low-cost launch range processes and facilities that will allow tomorrow's warfighter to be postured for rapid response to unanticipated crises.

Responsive Space: Joint Warfighting Space Demonstrations

AFRL is joining forces with the broader space community to demonstrate responsive warfighting space capabilities. Known

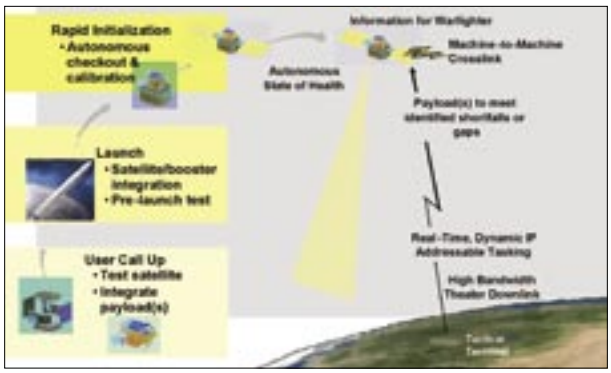


Figure 4. Joint Warfighting Space Demonstrations will test the ability of small (< 500 kilogram), low cost (< $20 million for total mission cost) satellites to be called up rapidly (less than six days) to provide tactical space capabilities such as intelligence, surveillance, reconnaissance, communications, blue force tracking, and data exfiltration to the theater commander.

as Joint Warfighting Space Demonstrations (JWS-D), or also as tactical satellite experiments (TacSats), these operational experiments will combine many elements: modular, plug-and-play satellite components; militarily critical payloads; low-cost responsive launch vehicles and ranges; semi-autonomous operations; command/control and data dissemination in a warfighting theater; and innovative science and technology development and acquisition processes. As shown in figure 4, these satellites will test the ability to call-up a spacecraft in less than six days to provide tactical space capabilities such as intelligence, surveillance, reconnaissance, communications, blue force tracking, and data exfiltration directly to an operational theater commander. The partners in this program include the Air Force, Army, Navy, Marines, DARPA, OFT, the National Reconnaissance Office (NRO), and US Strategic Command.

The first demonstration in this series is the TacSat-1 spacecraft, developed by the Office of Force Transformation and the Naval Research Laboratory. TacSat-1, using signal collection and geolocation sensors will find earth-based electronic transmissions and enable the warfighter to locate hostile forces. Operators will use the SIPRNET to remotely task and process results from the spacecraft. This satellite is scheduled to launch in late summer 2005 on the Space-X Falcon I launch vehicle from Vandenberg AFB.

AFRL is leading the second demonstration program, JWS D-1 "RoadRunner" (TacSat-2). This spacecraft will carry a panchromatic/three-color imager capable of collecting images with a resolution of approximately one meter. The spacecraft will take target requests directly form the theater, collect the requested images, and down-link these images directly to the user in the same orbital pass using a space-qualified, 274 megabits per second Common Data Link (CDL) terminal. This will enable the warfighter to obtain rapid enhancement of his or her battlespace awareness. The total demonstration mission cost is less than $50 million, including spacecraft, payload, launch vehicle, range support, military utility assessment, and one year of mission operations. This low cost was achieved in part by using an innovative acquisition and technology approach to building the space telescope. The telescope was built by an integrated government and industry team that modified a $25,000 amateur astronomy telescope so that it would operate in the space environment. This resulted in a "good enough" space

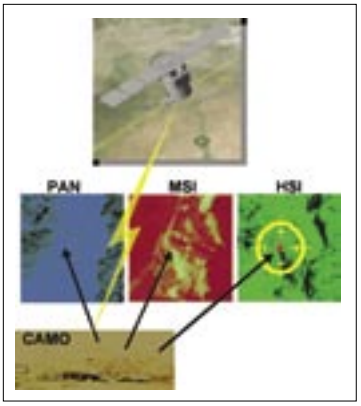
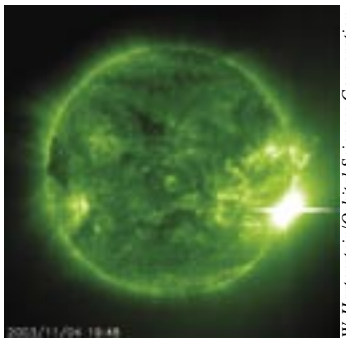


Figure 5. Compared to panchromatic (PAN) imaging, multispectral (MSI) and hyperspectral (HSI) imaging allows detection of targets by the reflected or emitted spectrum, rather than physical shape, enabling unprecedented discrimination against camouflage and foliage.

telescope for approximately $2 million total cost versus the industry estimated cost of approximately $15 to $20 million for a traditional aerospace telescope purchased as a turn-key system. The target launch date for JWS D-1 is late 2005.

The third experiment in the series is JWS-D2, jointly funded by the AFRL, OFT, and the Army. This experiment will fly a low-cost, quick-response hyperspectral imaging (HSI) sensor and a panchromatic camera combined with a CDL terminal that will enable images and target icons to be down-linked directly into a theater operations center. As shown in figure 5, hyperspectral imaging allows detection of targets by the reflected or emitted spectrum, rather than physical shape, enabling unprecedented discrimination against camouflage and foliage. The cameras will be combined with the first generation modular, plug-and-play spacecraft bus developed by AFRL and OFT. AFRL has teamed with the Army, Navy, OFT, and Space and Missile Systems Center (SMC) on this program to explore innovative business practices that will enable technologists, acquisition specialists, and operators to be involved in this program from the beginning to ensure "operational" production copies of this spacecraft can be rapidly acquired and placed in the field. The ultimate goal is to develop a rapid and streamlined path for technologies to move from the laboratory into the "hands of the warfighter." Launch for JWS-D2 is planned for the fall of 2006.

The fourth experiment in the series, JWS-D3, will be defined during the summer of 2005. Leading candidate payloads for this



W. Hartenstein/Orbital Sciences Corporation

Figure 6. The most powerful solar flare ever recorded occurred on 4 November 2003, shown here in extreme ultraviolet light. These events can cause satellite communication outages and failures in electronics.

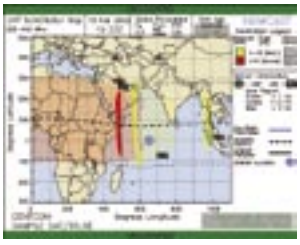


Figure 7. This communications outage map shows regions on the earth where space weather prevents satellite links from being received on the ground. Today, this AFRL-developed capability is widely used by military forces deployed around the globe.

mission are joint blue-force situation awareness sensors, data exfiltration sensors, and a small synthetic aperture radar. The final payload will be selected based on prioritized warfighter capability gaps, technical maturity, and cost.

Successful completion of the JWS series will demonstrate greater agility of our forces to project power rapidly across the globe in response to crises. By lowering the cost and time associated with space support, the power and pervasiveness of space-derived effects will be integrated into all levels of warfighting. It will demonstrate the rapid movement of innovative technologies from the laboratory to the battlefield. These eyes, ears, links, and beacons from the "high ground" of space will create unprecedented, synergistic effects on the battlefield.

Space Situation Awareness and Space Weather

Joint force command across the battlespace requires situation awareness on the surface, in the air, and in space. The space environment presents numerous hazards to military systems and operations, both directly through energetic particle effects on spacecraft and indirectly through effects on the data and communications links from space to ground. Our ability to forecast space weather is at a level of maturity similar to that of terrestrial weather forecasting forty years ago, while the requirements to support military operations with space environmental effects predictions are increasing. Ionospheric turbulence and the associated scintillation of electromagnetic signals can cause serious degradations and even outages in communications, navigation, surveillance, and radar operations, threatening warfighter safety and mission success. Today, AFRL operates a space-to-ground link monitoring network using ground-based sensors that provide communications and navigation outage maps at stations around the globe. A tactical space weather effects system was recently deployed to Baghdad, in support of the Third Infantry Division, with resounding success in aiding the resolution of Army communications problems. The Communications/Navigation Outage Forecast System (C/NOFS) satellite, to be launched in late 2005, will expand this capability by demonstrating enhanced operational outage forecasting from detailed *in-situ* ionospheric measurements. C/NOFS will provide the DoD with first-ever global scintillation forecasting capability. Outage maps will be provided to warfighting units across DoD through the classified internet.

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Colonel Kiziah entered the Air Force in 1981 as a distinguished graduate of the US Air Force Academy. He has served as an Air Force science and technology officer, Associate Professor of Physics at the US Air Force Academy, joint duty officer and deputy program manager within the Office of the Secretary of Defense, the Air Force Research Laboratory Commander's representative and staff member of the National Reconnaissance Office Advanced Systems and Technology Directorate, and Combat Support and Joint Counterair Division Chief at Headquarters US Air Force. Prior to his current assignment, he was the Materiel Group Director for Advanced Space Superiority of the Space Superiority Materiel Wing at Space and Missile Systems Center, at Los Angeles Air Force Base, California.

The most powerful solar flare ever recorded on 4 November 2003 is shown in figure 6 at extreme ultraviolet wavelengths. These eruptions are often associated with severe environmental effects on satellite systems, such as communications outages and damage to spacecraft components. A communications outage map, see figure 7, shows regions on the earth where space weather prevents satellite links from being received on the ground. This AFRL-developed capability is widely used today.

Satellites face hazards directly from charged particles ejected by the sun. Energetic particles can damage sensitive satellite electronics and other components resulting in dead or mission-impaired spacecraft. AFRL is developing environmental monitoring and anomaly detection systems, some of which are now flying on DoD satellites and attracting interest from commercial entities. These systems provide real-time warnings to operators and enable spacecraft designers to protect future satellites through smart design. In addition, by tracking solar events, spacecraft operators are able take precautionary steps to protect sensitive satellite components and plan mission operations to mitigate the effects of severe space weather events. Beyond sensing and forecasting the environment, simulations and experiments are conducted to develop mitigation technologies for effects such as spacecraft charging and reentry plasma blackout.

Conclusion

In 1955, former Air Force Chief of Staff, General Thomas D. White said "The United States must win and maintain the capability to control space in order to assure the progress and pre-eminence of the free nations. If liberty and freedom are to remain in the world, the United States and its allies must be in position to control space." Programs at the Air Force Research Laboratory are developing the technologies to make this vision a reality. The continued security of our Nation in the 21st century depends on their success.

Notes:

[1] The National Defense Strategy of the United States, March 2005.

[2] Peter B. Teets, "National Security Space in the Twenty-First Century," *Air and Space Power Journal*, Summer 2004.

[3] United Nations Registry of Space Launches, 2004, Section A: Main Registry of Satellites and Space Probes, Table 1: Index to registrations, on-line, Internet, available from http://planet4589.org/space/space.html.

[4] General Lance W. Lord, "Commanding the Future - The Transformation of Air Force Space Command," *Air and Space Power Journal*, Summer 2004.

Theater Space Operations in a Warfighting Headquarters

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Ramstein AB, Germany

** This essay is excerpted from another work currently in progress. The effort originated as research project for the 2005 Space Weapons Officer Conference.*

As space warfighters, these are historic times. Just as the Mercury 7 astronauts were on the forefront developing the first manned space flight tactics, techniques, and procedures (TTPs), today's space strategists, planners, and operators are on the forefront developing the first TTPs for how the air component will execute space operations today and in the future. The events of September 11th have driven the United States into a new combat environment, much of which involves enemies without uniforms who fight within undefined borders and are sponsored by nation states or non-state actors. This new strategic environment and the Global War on Terrorism (GWOT) have transformed Geographic Combatant Commands into Standing Joint Force Headquarters (SJFHQ). Similarly, theater air components are transforming into Warfighting Headquarters (WFHQ). The focus of the defense transformation is military forces able to conduct rapidly executable, full spectrum operations. Theater space operators, as well as those in the United States, must develop operational procedures that keep pace with this ongoing transformation. Theater space operations in this new environment must be responsive, streamlined, and flexible. They must also support full spectrum operations and adapt to non-traditional planning and execution methods. This article will identify five recommendations for addressing these imperatives and improving theater space integration at the operational level.

THE NEW STRATEGIC ENVIRONMENT

Every US government agency is transforming to meet new requirements brought about by this new strategic environment. Changes in policy and strategy have occurred at every level. The National Security Strategy, September 2002, outlines the new focus:

> Today, [the] task has changed dramatically. Enemies in the past needed great armies and great industrial capabilities to endanger America. Now, shadowy networks of individuals can bring great chaos and suffering to our shores for less than it costs to purchase a single tank. Terrorists are organized to penetrate open societies and to turn the power of modern technologies against us.
>
> The events of September 11, 2001, taught us that weak states…can pose as great a danger to our national interests as strong states. Poverty does not make poor people into terrorists and murderers. Yet poverty, weak institutions, and corruption can make weak states vulnerable to terrorist networks and drug cartels within their borders.[1]
>
> President George W. Bush, September 2002

Because weak states are vulnerable to terrorist networks, the United States, using all its instruments of power (i.e. diplomatic, information, military, and economic), must work to support nations to assist their defense against terrorist network infiltration. The level of military support must not only have the capability to execute major combat operations but have the capability to execute a full range of military operations such as noncombatant evacuation operations (NEO) and foreign humanitarian assistance (FHA). These requirements drive the Department of Defense into a transformation mode.

DEFENSE TRANSFORMATION

The Secretary of Defense and the Chairman of the Joint Chiefs have discussed the importance of a transformation to the defense of the United States and its interests:

> The purpose of transformation is to extend key advantages and reduce vulnerabilities. We are now in a long-term struggle against persistent, adaptive adversaries, and must transform to prevail.[2]
>
> National Defense Strategy, March 2005

> Sustaining and increasing the qualitative military advantages the United States enjoys today will require transformation - a transformation achieved by combining technology, intellect and cultural changes across the joint community. The goal is Full Spectrum Dominance – the ability to control any situation or defeat any adversary across the range of military operations.[3]
>
> National Military Strategy, 2004

The Department of Defense is transforming to operate in this new strategic environment. Each Geographic Combatant Commander (GCC) is organizing a SJFHQ and each major command's air component is organizing a WFHQ. These organizations support a rapid transition to a full range of military operations. Planning methods such as deliberate planning (DP) and crisis action planning (CAP) are giving way to adaptive planning, allowing strategists to develop "living" operations plans that are continually updated and ready for execution on much shorter timelines. The draft Joint Publication (JP) 3-0 discusses the range of military operations to include contributions to homeland security (HS), stability operations and major combat operations (MCO). Homeland security involves worldwide defensive and offensive actions. Stability operations include arms control, enforcement of sanctions and maritime intercept operations (MIO), ensuring freedom of navigation and overflight, FHA, foreign internal defense (FID), NEO, peace operations (PO), strikes and raids, recovery operations, and support to insurgency and counterinsurgency and counter-terror (CT). MCO typically involve a joint campaign with multiple phases.[4] The GCC using the SJFHQ has a primary role ranging from homeland security to major combat operations.

Standing Joint Force Headquarters (SJFHQ)

The SJFHQ model, developed by United States Joint Forces Command (USJFCOM) is intended to carry the defense transformation into the GCC's area of responsibility (AOR). Each SJFHQ includes expertise from various functional areas such as operations, intelligence, logistics, and communications; and places them under a single director. USJFCOM's SJFHQ prototype Concept of Employment states, "The SJFHQ is about transformation—thinking and operating differently, using networked knowledge and shared situational understanding in an effects based approach to planning and operations, as well as providing a coherently joint perspective to respond to demanding challenges of today's operational environment."[5] The SJFHQ is a full-time capability focused on warfighting readiness. The organization of the SJFHQ staff enhances situational understanding of focus areas, as designated by the GCC, within the AOR. Maintaining a daily focus on these "hot spots" allows the SJFHQ to provide the core capability for a joint task force (JTF) and enables a more rapid transition to any kind of military operation. A significant part of the SJFHQ is the service and functional components. The air components have a plan to quickly adjust to this new construct.

"WFHQs must be able to transition seamlessly from peacetime, day-to-day activities to major combat operations, and all levels of conflict in between."

- Air Forces Command and Control Enabling Concept

Warfighting Headquarters (WFHQ)

The air component within each SJFHQ is organizing into a WFHQ. The separation of these WFHQ from their traditional major command (MAJCOM) management staff serves the purpose of planning and preparing for contingencies within the AOR. Just like the SJFHQ, warfighting readiness is a WFHQ's primary purpose. The mission of the WFHQ is to plan, command, control, and execute air, space, and information operations (IO) capabilities across the full range of military operations. As outlined in the Air Force Forces Command and Control Enabling Concept, "WFHQs must be able to transition seamlessly from peacetime, day-to-day activities to major combat operations, and all levels of conflict in between."[6] Just as the SJFHQ must be ready to stand up a JTF, the WFHQ must be prepared to become the JTF. The decision to make the air component WFHQ the JTF will depend on the scope and duration of the operation. An air-centric operation, for example, most likely justifies the WFHQ as the JTF.

THEATER SPACE OPERATIONS IMPERATIVES

In order for theater space operations to transform in this new strategic environment, several imperatives must be addressed. First, theater space operations must be responsive, streamlined and flexible in order to respond to compressed timeline stability operations. Unity of command is as vital in theater space operations as it is in theater air operations. The most responsive operations occur when the joint forces air and space component commander (JFACC), as the single responsible commander, has direct access to forces conducting air and space operations in the AOR. Streamlined operations are possible when products used for planning and tasking space forces are standardized with those used for planning and tasking air operations. Maximum flexibility occurs when space strategists and planners within the joint air operations center (JAOC) work side-by-side with air and IO strategists and planners collocated in the JAOC. Effective integration and synchronization with other component operations also occurs in the JAOC through the liaison elements. Second, like any other instrument of military power, theater space operations must support full spectrum operations. Space operations strategists and planners within the WFHQ must have intimate knowledge of the AOR and the possible range of operations. In coordination with the SJFHQ, strategists and planners within the WFHQ must strive to continually analyze and understand the environment in which they operate. Third, theater space operations must support non-traditional planning and execution. Military training in the pre-9/11 era focused around major combat operations lasting weeks, months, or years. Doctrine focused on conducting large scale operations against an adversary of equal or almost equal capability. Today, most theaters are planning for and conducting operations on very compressed timelines against high-value, fleeting targets. United States European Command (USEUCOM), United States Central Command, United States Special Operations Command, and United States Strategic Command have planning models that work on similarly compressed timelines. Positions, processes and products must be in place today in order to conduct rapidly executable, full-spectrum theater space operations in today's new strategic environment.

RECOMMENDATIONS

Great strides have been made in recent years integrating space capabilities at the operational level of war. These five recommendations for the improvement of positions, processes, and products within a WFHQ address theater space operations imperatives and ensure these operations keep pace with the defense transformation. Each theater has implemented portions of these recommendations; however, they are not normalized and standardized across all of the theaters.

1) Identify Standing Director of Space Forces per AOR

Operations ENDURING FREEDOM and IRAQI FREEDOM and many exercises since have identified the need to have a senior space presence on the COMAFFOR or JFACC personal staff. The position, once known as the Senior Space Officer (SSO), has transformed into the Director of Space Forces or

DIRSPACEFOR. According to Air Force doctrine document (AFDD) 2-2.1 *Counterspace Operations*, "the DIRSPACEFOR conducts coordination, integration, and staffing activities to tailor space support for the COMAFFOR/JFACC."[7] Either wing commanders or previous operations group commanders from Air Force Space Command currently hold the position of DIRSPACEFOR. Often times these Colonels arrive in theater at the beginning of a contingency or exercise without adequate AOR-specific training or situation awareness. The expectation is they get "spun up" very rapidly. The uncertainty and instability of ungoverned spaces around the globe combined with compressed planning timelines do not allow the luxury of training the DIRSPACEFOR adequately during the rapid build-up prior to mission execution. AFDD 2-2.1 outlines several responsibilities of the DIRSPACEFOR—many of which occur during adaptive planning, sometimes long before execution. These responsibilities are best suited to the permanent presence of a trained DIRSPACEFOR in theater.

In order to take full advantage of a permanent-party DIRSPACEFOR, they must receive general roles and responsibilities training as well as AOR specific training. Air Force Space Command (AFSPC) has done a great deal of work establishing a baseline DIRSPACEFOR initial qualification training (IQT) program. The natural extension of this initial training is for AFSPC to develop continuation training and for each theater to provide theater-specific mission qualification training (MQT) as well as continuation training. Theater MQT and continuation training will include frequent situation awareness about activities within the AOR. Once trained and in theater, the DIRSPACEFOR will be equipped to provide input from adaptive planning to execution to redeployment. A DIRSPACEFOR "living and breathing" within the theater WFHQ is the most effective use of this valuable resource.

2) Integrate Space Operations Expertise into WFHQ Operational Planning Teams

As mentioned above, a WFHQ must be able to seamlessly, and sometimes rapidly, plan and execute a full range of military operations. This seamless transition from planning to execution requires close coordination across all mission areas between the Air Force forces (AFFOR) staff (A-Staff) and the JAOC. Traditionally, responsibility for DP and CAP rested with the A-Staff which required little input from the JAOC Strategy Division. This type of relationship required the JAOC to "spin-up" rapidly and, in some cases, duplicate planning efforts to effectively meet the joint force commander's objectives. Further, there are multiple examples identifying the disconnect between A-Staff A3/5 collateral-level CAP and A-Staff A39 special technical operations (STO)- level CAP. Many times the two planning efforts occurred simultaneously without any interaction between the two planning groups. It is very difficult to develop a single air component strategy when the A-Staff and the JAOC do not effectively coordinate across all functions. The WFHQ construct allows the A-Staff and JAOC Strategy Division to work closely on DP and CAP. The C2 enabling concept (CONOPS) mentions the establishment of an Operations Planning Group or a Long-range Planning Group, but does not include options for implementing. USAFE is developing a model that establishes operational planning teams (OPT) that mirror the EUCOM SJFHQ OPTs. These OPTs are focused on the different ranges of military operations such as CT, NEO and FHA. Within each of these OPTs, there are functional area experts from both the A-Staff and the JAOC. Just like the SJFHQ is tasked to analyze "hot spots" specified by the GCC, the WFHQ OPTs, as the air component reps to the SJFHQ, focus their efforts on analyzing the same regions. In order to effectively plan and execute theater space operations, it is imperative these OPTs include space operations personnel from both the A-Staff as well as the JAOC. This type of coordination and organization provides a seamless transition from DP and CAP within the A-Staff to execution within the JAOC.

3) Normalize a Space Coordinating Plan

When designated as the area air defense commander (AADC) the JFACC outlines air defense operations in an area air defense plan (AADP); likewise, in their role as the airspace control authority (ACA), airspace operations is outlined in an airspace control plan (ACP). When designated as the space coordinating authority (SCA), the JFACC should outline space operations coordination within a space coordinating plan (SCP). AFDD 2-2.1 states, "The commander with SCA is the single authority to coordinate joint theater space operations and integrate space capabilities. The SCA facilitates unity of effort within theater by coordinating joint theater space operations to support integration of space capabilities and having primary responsibility for in-theater joint space operations planning."[8] Although the JFACC's joint air and space operations plan (JAOP) outlines the overall conduct of air, space and information operations it does not go to the level of detail that is contained within an AADP or ACP. The AADP and ACP outline the method by which operations will be conducted, the units conducting operations with associated command and control details, the interaction between each unit, the communications equipment used for operations, and the battle rhythm that each unit will follow. These plans offer a "one-stop-shop" for both the producer of effects and the user of effects. The SCP should offer producers and users of space-derived effects a common reference to understand how effects are produced and the method by which they are requested. Central Air Forces (CENTAF) has developed a model SCP, but it has not yet been normalized across the theaters.

4) Normalize an Integrated Tasking Order

The JFACC uses the air tasking order (ATO) as the mechanism for which to task air assets under his tactical control; likewise, the mechanism used to task space assets under his tactical control is the theater space tasking order (S-T-O). (Note, there are two types of S-T-Os, one which directs global space operations and is published by the 14 AF Space AOC and the other developed for theater-specific space operations.) In order to effectively synchronize air and space operations – kinetic and non-kinetic effects – these assets should be tasked via an integrated tasking order (ITO). Right now, production and distribution of

the ATO and S-T-O occurs independently from each other. As the JAOC becomes a weapons system, much time and money is being invested to automate the ATO process from strategy development through ATO production. Similar tools do not exist on the space operations side, relegating much of the S-T-O process to manual procedures. Combining the ATO and S-T-O into a single ITO, theater air and space planners could take advantage of the existing tools already developed. The ITO would then be sent to mission planning cells (MPC), both air and space, which will produce the detailed mission plans the tactical units will execute. The ITO, which includes information such as platform, target, timing and effect, will provide insight to mission commanders and package commanders on the assets supporting the overall mission. The ITO would be produced from a single integrated master air attack plan (MAAP). The MAAP briefing would contain both kinetic and non-kinetic effects and present the JFACC with an overall picture of that day's air and space operations. Pacific Air Forces (PACAF) currently uses an ITO, but it has not been normalized across the theaters.

5) Normalize a Reconnaissance, Surveillance and Target Acquisition Annex

The reconnaissance, surveillance and target acquisition (RSTA) Annex is an attachment to the daily ATO that provides detailed tasking for intelligence, surveillance and reconnaissance (ISR) sensors and processing, exploitation, dissemination (PED) nodes supporting the JFACC. According to Air Force Operational Tactics, Techniques, and Procedures (AFOTTP) 2-3.2 Air and Space Operations Center, "This product outlines the entire JFACC ISR plan for a given ATO, possibly at multiple classification levels."[9] No standardized and normalized RSTA Annex for ISR supporting theater space operations presently exists. As mentioned above, just as theater space operations should be tasked via the ITO, ISR sensors supporting them should be tasked via the RSTA Annex as well. Personnel within the ISR Division of the JAOC produce the overall RSTA Annex. Currently, space or IO personnel develop the collection plan for theater space operations. However, ISR Division personnel should be responsible for production of the entire RSTA Annex. This will require "space-smart" intelligence personnel permanently assigned to the ISR Division. PACAF and USSTRATCOM have developed a RSTA Annex in support of exercises but it has not been normalized across theaters.

CONCLUSIONS

The strategic environment has fundamentally changed. Consequently, the US government (specifically the Department of Defense) is in the midst of a transformation. The Department of Defense is transforming the geographic combatant commands and major commands to maintain day-to-day wartime readiness by continual situational awareness of activities within their AOR. This continual situational awareness and wartime readiness allows for a more rapid transition to full spectrum operations. Theater space operations imperatives must be addressed within a WFHQ to ensure these operations effectively integrate with other operations. For theater space operations to react rapidly and provide a critical contribution to full spectrum operations, positions such as an identified DIRSPACEFOR per AOR, processes such as space operations personnel on WFHQ OPTs and products such as a normalized SCP, ITO and RSTA Annex are essential.

Notes:

[1] National Security Strategy of the United States, September 2002.
[2] National Defense Strategy of the United States, March 2005.
[3] National Military Strategy of the United States, 2004.
[4] Draft JP 3-0, *Doctrine for Joint Operations*, 15 September 2004.
[5] USJFCOM SJFHQ Concept of Employment, 25 June 2003.
[6] Air Force Forces Command and Control Enabling Concept, 10 February 2005.
[7] AFDD 2-2.1, *Counterspace Operations,* 2 August 2004.
[8] AFDD 2-2.1, *Counterspace Operations,* 2 August 2004.
[9] AFOTTP 2-3.2, Air and Space Operations Center, 14 December 2004.

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Joint Warfighting Space and C2 of Deployable Space Forces

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The Air Force has made great strides at integrating space effects into theater combat operations. Today, space operators work day-to-day in theater Air and Space Operations Centers (AOC) and on combatant commander's staffs. However, the ongoing debate on the command and control of deployable space forces has hampered development of command and control mechanisms and associated training and exercises. At the heart of the issue is unity of command, a deeply engrained principle of warfare. In fact, Napoleon Bonaparte said, "nothing is more important in war than unity of command."[1] Yet, achieving unity of command and unity of effort for space forces continues to challenge military planners, doctrine writers, and staffs. Traditionally, space forces have been thought of as global and some argue, "space is inherently global."[2] Newly developed capabilities and organizational constructs may shift that mindset.

Space operations is rapidly expanding from traditional force enhancement roles, to include on-orbit, near space, and deployable forces, which will be able to provide direct effects on the battlefield to achieve joint force commander (JFC) objectives. For instance, new deployable counterspace capabilities, such as the Counter Communications System (CCS), can deny adversary communications directly for the theater warfighter.[3] How will we command and control these new capabilities?

This article proposes an expansion of the Joint Warfighting Space (JWS) operating concept, currently in draft, as the means to achieve unity of command for deployable space forces and provide dedicated, responsive effects to theater commanders. The mission statement of JWS provides a vision of the future: "Expeditionary space forces develop, plan, and execute responsive JWS operations under JFC control to achieve desired effects of rapid theater response, space superiority and decision superiority to successfully accomplish operational and tactical missions in support of strategic objectives."[4] However, currently JWS only addresses on-orbit and near space capabilities in development.[5] It does not resolve the debate over deployable space forces, such as CCS, which will undoubtedly be part of a growing offensive counterspace (OCS) component of theater campaign plans. Resolving this long-standing issue will improve the integration of space forces into combat operations.

Past Command Relationships

It is important for the reader to understand where we are going with command and control of deployable space forces. A variety of command and control relationships for deployable space forces, including operational control (OPCON), tactical control (TACON), "Split-TACON" and Direct Support, have been used in recent exercises and contingencies. However, we have yet to achieve a "normalized" presentation of deployable space forces to the theater, despite the language in AFDD 2-2, Space Operations, which states, "When deployed, Air Force space forces are normally attached to an Air and Space Expeditionary Task Force (AETF) under OPCON of the COMAFFOR."[6] This is far from a new issue; the debate over command and control of deployable space forces has now lasted almost a decade. In this article, we will look at recent command relationships in Operation ENDURING FREEDOM (OEF) and Operation IRAQI FREEDOM (OIF).

Operation ENDURING FREEDOM

Command relationships for deployable space forces were an issue during preparations for OEF. Ultimately, command relationships were resolved with the development of a "Split-TACON" relationship and ad hoc command and control procedures. The "Split-TACON" relationship existed between deployable space forces and the combined forces air component commander (CFACC), who had TACON for execution, and COMSPACEAF, who had TACON for planning. Imagine the dilemma of a space crew commander receiving conflicting direction from two different organizations with TACON. The OEF experience raises a couple of key questions for warfighters. Is unity of command possible with a "split" command

"Expeditionary space forces develop, plan, and execute responsive JWS operations under JFC control to achieve desired effects of rapid theater response, space superiority and decision superiority to successfully accomplish operational and tactical missions in support of strategic objectives."

- Mission Statement of Joint Warfighting Space

relationship? Is space so different that it requires new command relationships not in our joint or Air Force doctrine?

Operation IRAQI FREEDOM

Central Command Air Forces (CENTAF) and Space Air Forces (SPACEAF) discussed command relationships extensively in preparation for OIF. The CFACC requested TACON, while initially only Direct Support was offered. Ultimately, TACON was established as the command relationship.[7] However, the coordination of roles and responsibilities between the CENTAF Prince Sultan Air Base (PSAB) CAOC and the Space AOC continued well into combat operations. This ad hoc coordination of procedures, roles and responsibilities may have been avoided if the Air Force had emerged from OEF with a clear vision for command and control of deployable space forces. Similarly, different organizations took dramatically different lessons from OIF regarding command relationships. They varied from OPCON to theater is required to Direct Support is the best relationship.

One key takeaway, which all members of the space community should consider is that the lessons learned conference(s) must include all of the principal players. SPACEAF, CENTAF, and US Strategic Command (USSTRATCOM) all hosted separate lessons learned conferences following the conclusion of OIF major combat operations. However, all three conferences lacked many of the key players from other organizations to effectively work through outstanding issues or address the wide variance in space "lessons learned."[8]

The debate over roles and responsibilities within command relationships continues today. Theaters continue to advocate for OPCON/TACON of deployable space forces and 14 AF continues to advocate Direct Support as the optimal relationship. Support is a command relationship; however, it is "by design, a somewhat vague but very flexible arrangement."[9] The supported commander will exercise general direction, but the supporting commander determines forces, tactics, methods, procedures, and communications. The supporting commander takes actions to fulfill the needs of the supported force, "within existing capabilities, consistent with priorities and requirements of other assigned tasks."[10] Thus, the supported commander in theater may not get required support based on other priorities outside the JFC's control. Resolving disagreements is difficult when issues arise, since the common superior is the SECDEF.

While theaters advocate for OPCON/TACON, some in the space community believe, "current C2 constructs for air, land, and sea might suffice if space power were not different from other forms of military power."[11] We see this kind of thought manifest itself in terms such as "Split-TACON." However, after thorough review of Joint Publication 0-2, Unified Action Armed Forces (UNAAF), a reader will not find different C2 constructs for air, land, and sea. In fact, the joint community treats global space forces like global mobility forces with global command and control. In the same vein, a JFC has theater mobility assets assigned or attached and should have theater space assets assigned or attached as well.[12]

Recent exercises have included both TACON and Direct Support relationships. The success or failure of these relationships depends on your point of view. However, the struggle to agree on roles and responsibilities continues and the lack of a normalized presentation of forces persists. This continued debate on command relationships deflects focus from the full integration of space effects into joint warfighting. While our space doctrine outlines OPCON as the "normal relationship," there has been resistance to efforts by theaters to exercise OPCON of deployable space forces. Two myths on space power employment play a role in this resistance.

SPACE MYTHS

Myth #1 – Space power is inherently global. Most of our current space capabilities are on-orbit assets and are part of global constellations. However, we must step back from the generalization that *all* space capabilities are global. The JWS concept addresses this issue and states, "JWS will drive changes to our space doctrine and drive us to reconsider the 'all space is global' dogma."[13] Additionally, our current space doctrine recognizes that there are different types of space forces: global space forces, theater space forces, and theater organic space force.

Theater space forces, such as our deployable counterspace forces, need to become an organic part of the JTF as effects providers. TSgt James Logan of the 76th Space Control Squadron, stated the following, "it [CCS] is a mobile, no-kidding tool that will be deployed – if needed – to assist theater commanders."[15] CCS is not deployed 24/7/365, but will deploy when required to meet theater requirements and will likely support a single theater. CCS is a theater space force, not a global space force.

Myth #2 – Space power must be centrally controlled globally by a space professional. This myth is included in Maj M. V. Smith's work "Ten Propositions Regarding Space Power" as Proposition No. 4.[16] A variation of this is included in Maj Samuel McNiel's work, "Proposed Tenets of Space Power" as Tenet Two.[17] While most space forces are global in nature and require global centralized control, not all space power assets require this global control. We must shift our paradigm and JWS

Counter Communications System (CCS)

is starting this shift: "any assumption that JWS assets must be centrally controlled by commanders outside the supported JFC's area of responsibility (AOR) is counter to this concept. We must think outside the box…"[18]

Operation TORCH and the Battle of Kasserine Pass during World War II taught us valuable lessons about unity of command and the value of centralized *theater* command and control.[19] This is exactly what *theater* commanders want, centralized theater command and control of space assets launched or deployed specifically to support their operations. However, global space power advocates argue we must replace *theater* with *global* and control all space forces on a global basis to prevent "penny packets."[20] Again, while most space assets need global centralized control, this does not apply to all space forces. When a JFC requests a CSS deploy to support his operations, transferring OPCON to theater creates an uncomplicated and clear chain of command. It also provides a dedicated and responsive asset to the theater warfighter.

Another often-cited reason for global centralized control is the high demand/low-density nature of space forces.[21] Will deployable forces, such as CCS, be a high demand asset with combat requirements in multiple AORs at the same time? It is too early to tell, but as we field dedicated capabilities, we must ensure space forces are available to support our 1-4-2-1 National Military Strategy with dedicated assets.[22] Not all space forces are the same and our emerging deployable, near space, and tactical on-orbit capabilities must not be forced into an "all space is global and must be centrally controlled" package. Can our space doctrine guide us?

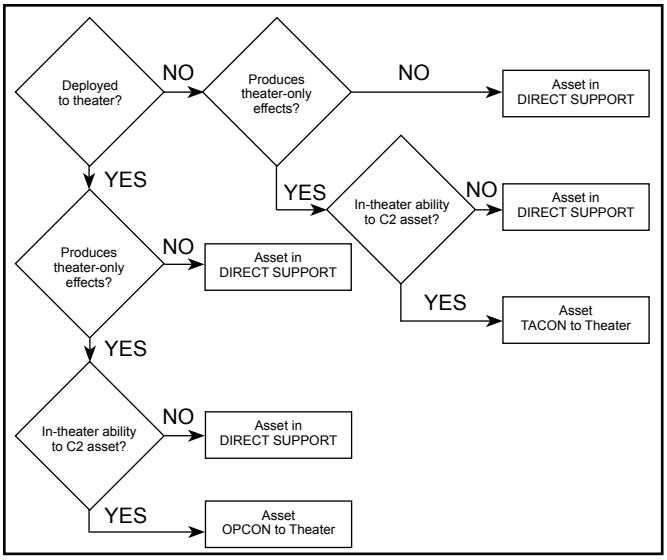
SPACE DOCTRINE

AFDD 1 states, "Air and space doctrine is a statement of official sanctioned beliefs and warfighting principles that describe and guide the proper use of air and space forces in military operations."[23] It also shapes "the manner in which the Air Force organizes, trains, equips, and sustains its force."[24] However, in our space doctrine, it is unclear what the official belief is regarding C2 of deployable space forces. This lack of clarity impacts how the Air Force organizes, trains, equips, sustains, and employs deployable space forces.

AFDD 2-2, *Space Operations*

AFDD 2-2 is ambiguous enough that it provides little help for commanders on command relationships for deployable space forces. Consider this statement from AFDD 2-2, "When the effects are focused primarily on an individual theater [requirements], space forces are normally the responsibility of the theater geographic combatant commander. These forces can produce strategic, operational or tactical effects."[25] To a theater warfighter, this passage supports change of operational control (CHOP) to theater. However, other sections seem to support maintaining OPCON/TACON in USSTRATCOM.

AFDD 2-2 also states, "USCINCSPACE [CDRUSSTRATCOM] would retain OPCON if the deployable space force operations will have global impacts. If the space force's operation only impacts the individual theater, the NCA may direct USCINCSPACE [USSTRATCOM] to transfer the space forces to the geographic CINC [combatant commander (GCC)]. The normal relationship will be OPCON, however, a TACON or support relationship may be appropriate depending on the ability of the theater commander to conduct space operations planning."[26] Look no farther than our previous discussion on the myth that space is inherently global to see how this passage is used to cite why deployable space forces should not be transferred to theater. Some view any impact (including collateral, secondary, and/or tertiary effects) outside an individual theater as a global impact.



C2 Decision Tree from AFDD 2-2.1

AFDD 2-2.1, Counterspace Operations

The growing importance of counterspace operations in modern warfare became clear on 2 August 2004 with the publication of AFDD 2-2.1, *Counterspace Operations*. This document "provides operational guidance in the use of air and space power to ensure space superiority."[27] While the command and control section is ambiguous and subject to interpretation, this document addresses key planning issues including a effects-based approach, legal considerations, course of action development, targeting, deconfliction, approval authority, rules of engagement (ROE), and assessment. There is also a chapter dedicated to command and control of counterspace forces. This chapter includes a decision tree.

The decision tree asks three questions. (1) Deployed to theater; (2) Produces theater-only effects; and (3) In-theater ability to C2 asset? These three questions are at the core of debate over command and control of deployable space forces.

Deployed to theater?

Based on the decision tree, if the asset is not in the theater, USSTRATCOM would not transfer OPCON. For instance, if US Central Command (USCENTCOM) required a counterspace asset and the asset deployed to the USEUCOM AOR to support

CENTCOM, USSTRATCOM would not transfer OPCON. However, this is not consistent with Air Force doctrine. As highlighted in Doctrine Watch 3 on OPCON, "forces bedded down in one CINC's [GCC's] AOR but conducting operations in support of a different CINC [GCC] should be OPCON to the CINC [GCC] charged with the operational mission (the supported commander)…"[28] This question should be removed from the decision tree.

Produces theater-only effects?

What should we consider theater-only effects? Theaters can interpret this as producing required effects for an individual theater. Others interpret theater-only effects as no collateral, secondary, or tertiary effects felt in other theaters. However, space forces are far from unique in their ability to create effects, which cross AOR boundaries. Does the kinetic destruction of a phone switch in Baghdad or a Marine killing an unarmed insurgent in Fallujah on satellite TV, create effects outside CENTCOM? Of course it does. In our global information age, it is almost impossible for the US to conduct military operations without effects spilling across AOR boundaries.

Effects across AOR boundaries is not a space issue, it is a warfare issue. The other GCC's and Joint Staff/OSD must be involved in coordination to ensure they are aware of possible effects in other AORs and we require tools to model these effects. This coordination applies to all joint forces, not just space forces. The better question at this point in the decision tree: Is the asset producing required effects for an individual theater?

In-theater ability to command and control asset?

OEF and OIF have demonstrated the capability to C2 space forces in-theater. During these conflicts, operational level planning and execution was conducted in the CENTAF PSAB CAOC. Tactical level planning was conducted in the Space AOC in Direct Support to the CFACC. The Space Tasking Order (S-T-O) sent to deployed space forces was created by the Space AOC based on the CFACC's air operations directive (AOD) and master air attack plan (MAAP) guidance. The S-T-O was approved by and was an order from the CFACC. Falconer AOCs are also increasing manpower to support space operations.

Space integration efforts in theater have increased dramatically over the past five years. Permanent party space integration in the AOCs began with W13S (Space Weapons Officers), however it has expanded dramatically to include 13S (Space Operators) and 1C6 (Enlisted Space Technicians). In 2001, the USAFE AOC had two W13S, one 13S, and two 1C6 personnel. While in 2004, the USAFE AOC had three W13S, six 13S, and five 1C6 personnel.[29]

Traditionally, Falconer AOC space personnel have been O-4 and below. During OEF and OIF, a senior space officer was deployed to the PSAB CAOC to advise the CFACC. This position has evolved into the Director of Space Forces (DIRSPACEFOR) position, which is outlined in AFDD 2.2-1. In OIF, the senior space officer proved invaluable working big picture issues for the CFACC, such as Space Coordinating Authority delegation, allowing AOC space personnel to execute their divisional responsibilities.

FORK IN THE ROAD

A decision on the future of space operations integration into joint warfare is upon us and we find ourselves at the proverbial fork in the road. Should we treat space assets supporting the requirements of a single theater just like other assets and CHOP them to theater? Or should we centrally control all space forces with global command and control through a Direct Support relationship with the Theater(s)?

> *"C2 of joint operations begins by establishing unity of command through the designation of a JFC with the requisite authority to accomplish assigned tasks using an uncomplicated chain of command."*
>
> **- Unified Action Armed Forces**

Doctrine can guide us, as outlined in the UNAAF: "C2 of joint operations begins by establishing unity of command through the designation of a JFC with the requisite authority to accomplish assigned tasks using an uncomplicated chain of command."[30] The transfer of OPCON to the JFC, likely delegated to the Commander, Air Force forces (COMAFFOR)/joint force air component commander (JFACC), will provide the unity of command and unity of effort required for the most effective integration of deployable space forces. Roles and responsibilities are clear and there is an uncomplicated chain of command for deployed unit planning and execution. AFDD 2-2 has it right: "the normal relationship will be OPCON."[31] The AFSPC Strategic Master Plan (SMP) FY06 and Beyond articulates a vision for the future of deployable counterspace forces.

The SMP articulates three strategic goals for counterspace (CS) mission area planners: (1) dominant CS Capabilities; (2) a Balanced Mix – between space-based and terrestrial (air or surface); and (3) full theater integration. Full theater integration as outlined in the SMP would resolve most, if not all, of the outstanding command and control issues. As outlined, the theater COMAFFOR would plan for CS effects, synchronize CS effects with joint forces, task CS forces directly from theater operations centers, adjust operations during execution, and integrate CS feedback into combat assessment/operational assessment. In short, the theater COMAFFOR would plan, synchronize, task, execute, adjust, and assess CS operations.[32] While it does not specifically address command relationship, this is consistent with OPCON/TACON to the theater COMAFFOR. Additionally, General Lance W. Lord,

commander, recently said, "we want … space to be employed like any other theater asset."[33] General Lord and the AFSPC SMP have outlined the vision, but the hard work is turning the vision into reality. The expansion of Joint Warfighting Space (JWS), to include deployable space forces, is the right concept at the right time to place a robust complement of space warfighting capabilities under the control of the JFC.

JOINT WARFIGHTING SPACE

The JWS concept developed by AFSPC is a visionary work. JWS seeks to make space an organic part of joint task forces in theater. It seeks to do this by "optimizing existing space capabilities and developing/employing improved space and near space systems."[34] There are six attributes outlined in the Joint Warfighting Space concept: (1) Responsive – trained, ready and deployable space forces; (2) Integrated – integrates with air, land, sea and information forces; (3) Dedicated – when JWS forces CHOP to JFC, they become dedicated theater assets; (4) Expeditionary – rapidly deployable, employable, and sustainable; (5) Interoperable and Networked – compressed kill chains through networking; and (6) Precision – high level of precision required to produce precision effects.[35] While deployable space forces are not currently part of the JWS concept, these attributes apply to them as well.

JWS will utilize an expeditionary space construct within our current AEF construct.[36] This is evidence that space is not so different and effective command and control of space forces can be conducted within existing command relationships and C2 constructs. However, because the current JWS concept fails to address deployable space forces, we may have an operation where a JFC has OPCON of an on-orbit asset dedicated to support his operation, but not have OPCON of a deployable asset sitting outside his command center also dedicated to support his operations.

JWS addresses a critical shortfall in the current space architecture by providing dedicated and responsive space forces. Currently, the JFC and JFACC compete against other theaters and national requirements for space assets. Air Force Chief of Staff, General John P. Jumper's White Paper highlights that JWS "takes operational and tactical level warfighting priorities out of competition with strategic priorities."[37] In the past, competition with strategic priorities has led to some overall inefficiencies and duplication of efforts. For instance, a JFACC may request space support, which competes with other theater or national requirements. However, since his request may not have a high enough priority to guarantee support, he may also task a theater asset. In the future with dedicated JWS assets, a JFC/JFACC can select the optimal dedicated assets to produce the required effects.

Expansion of Joint Warfighting Space

The AFSPC SMP FY06 and Beyond outlines a vision for counterspace, which includes full theater integration.[38] However, given the varying interpretations of our current space doctrine, it is difficult to visualize how we will execute this vision. While JWS was born under a slightly different context, the overarching concept and key attributes facilitate rapid and effective incorporation of deployable space forces. This expansion would provide a JFC with a range of on-orbit, near space, and deployable space forces that would be dedicated and responsive to the requirements of the theater. There are clear benefits to expansion of the concept.

Unity of Command

Deployable space forces in an expanded JWS construct would CHOP to the JFC, likely delegated to the COMAFFOR/JFACC. The deployable space forces would be part of an AETF in a Space Expeditionary Wing (SEW) or Space Expeditionary Group (SEG). For example, a SEG would be composed of a group command element and one or more squadrons. A key component of the SEG is a Mission Planning Cell (MPC) responsible for tactical level mission planning based on the theater air tasking order (ATO)/integrated tasking order (ITO). Operational and tactical level planning and execution would reside under a single chain of command, ensuring the unity of command for JWS forces under the JFC. This is a normalized presentation of forces and provides the uncomplicated chain of command outlined in the UNAAF.

Standardized Training and Execution of Forces

Resolving the command relationship issue and providing a normalized presentation of forces will allow long-standing training and execution issues to be standardized. Joint training is traditionally an OPCON function.[39] Prior to OIF, the CFACC conducted joint training events with attached deployable space forces to ensure they were prepared for operations. This training was beneficial and worked out many command and control procedural issues prior to combat operations. As we normalize to an OPCON presentation of forces, standardized AOC and unit training will help ensure forces are prepared for a baseline command and control architecture. An additional dividend will be ongoing training that should occur between JWS units and theater AOCs.

Out-of-cycle training exercises between JWS units and theater AOCs will be necessary to enhance unit and AOC effectiveness and readiness for combat operations. Additionally, AFSPC can effectively organize, train, and equip its forces for CHOP to theater and provide valuable assistance in developing training programs and leading efforts to standardize efforts between the theaters. JWS captures the importance of training; "the 'train as you fight' philosophy must be extended to routinely include JWS forces to operationalize space as core versus specialized capabilities."[40]

Dedicated Assets

Deployable space forces will be valuable contributors as an organic part of the JTF. When a JFACC requires a critical military communications link be disrupted, he or she may have several kinetic and non-kinetic options at their disposal. If the JFC/JFACC has OPCON/TACON of various options, this

allows theater planners to find the optimal solution and provides the ability to execute it directly with forces under its control. In a Direct Support relationship, the supporting commander with TACON of counterspace assets may have other priorities and requirements within its assigned tasks, which prevent them from providing required support in a timely manner.[41] Thus, the JFACC may have to plan and use other kinetic or non-kinetic options to ensure achievement of desired effects, even if a ground-based counterspace system is the best solution. The proper execution of JWS can go a long way toward ensuring that space assets optimally contribute to achievement of the JFC's objectives.

Trained Personnel to Augment Theater AOCs

Deployable space forces, including counterspace forces, will almost certainly be critical components of future theater campaign plans. As discussed earlier, Falconer AOCs have dramatically increased their number of space personnel. However, to effectively plan, task, and direct deployable space forces CHOPed to the COMAFFOR/JFACC, additional trained and experienced personnel will be required. JWS can provide these qualified personnel to augment the Falconer AOCs, when required. The intent should be for JWS personnel to become integral parts of the various Falconer AOC teams, where they will work with permanent party space personnel to ensure the optimal application of space force capabilities to create warfighting effects. However, there are also some issues with JWS expansion.

Increased Footprint in Theater

The Air Force has made a concerted effort over the past several years to reduce the forward footprint of our AOCs in wartime. One could certainly argue about the effectiveness of Air Force efforts, considering the 1500+ person CAOC during OIF. However, of those 1500+ personnel less than twenty were space operators. JWS will increase space presence in AOCs at a time when the Air Force is attempting to draw down overall numbers. However, perhaps this is looking at the glass half-empty.

The Air Force has gone to great lengths to be inclusive of space operations and AOCs are now "Air and Space Operations Centers." To become true Air and Space Operations Centers, a more robust space presence to support counterspace and overall space support is a move in the right direction, for both the Air Force and the space community. The experience space personnel will gain working with joint military planners and operators will help build the desired warrior culture in the space community and aid the transition from Air Force Space Command to Space Combat Command.

Expansion of JWS will likely slow JWS approval

JWS is currently in draft form, expansion will likely slow the approval of the overall concept due to the re-writing and re-staffing required. Since the expansion includes the command and control of deployable space forces, the coordination process inside and outside AFSPC could be lengthy. However, there is a positive to the concept still being in draft form.

The draft status of JWS provides the opportunity to expand the concept now. Deployable space forces are more mature platforms than future JWS on-orbit and near space capabilities. They can lay a solid foundation for command and control of future JWS forces. The concept also calls for JWS to provide immediate and near-term capabilities to support JFC needs, which deployable space forces can provide.[42]

USSTRATCOM and its Components Remain Indispensable

While some on-orbit, near space, and deployable capabilities may be CHOPed to theater with JWS, USSTRATCOM and its components remain indispensable to the theater warfighter. Assistance with COA development, intelligence, deconfliction, and assessment will be key USSTRATCOM roles in an expanded JWS for deployable space forces. JWS does not seek to recreate the Space AOC/Joint Space Operations Center (JSOC) in each individual theater. However, it does bring the required footprint forward to conduct operational and tactical level planning and execution. USSTRATCOM maintains its global space role and provides critical reachback support to theaters. The vast majority of space forces will continue to be executed through centralized global command and control through the JSOC and National agencies.

CONCLUSION

The expanded JWS concept has the potential to revolutionize the integration of space operations in theater. Global space forces will remain essential to effective JTF operations, while JWS forces will provide a range of space capabilities dedicated and responsive to the specific requirements of the JFC. An expanded JWS will execute the AFSPC SMP, as we move beyond the ambiguous doctrine and infinite loop of discussions on roles and responsibilities to execute a concept, which recognizes both the global and theater perspectives of space power employment.

This article examined recent contingencies and showed a variety of relationships have been used with deployable space forces. A shared belief on proper command and control relationships has been elusive. Deployable space forces have had OPCON, TACON, "Split-TACON," and Direct Support relationships. Unfortunately, the lessons learned have rarely been the same inside and outside the space community. All parties must work together to give future lessons learned conferences a chance to succeed.

Further, we examined two myths of space power employment. The first myth was space power is inherently global. While we often think of space forces as on-orbit satellites, we also have deployable space forces, which can deploy and support individual theaters. Thus, space forces cannot be pigeonholed into a one-size-fits-all "space is global or else" mentality. The current JWS concept is addressing this issue and it recognizes the need to step back from the "space is global" dogma.

The second myth, built upon the first, is space must be centrally controlled globally by a space professional. An asset deployed or launched, for the specific purpose of supporting a theater JFC, is not a global asset and is not being broken into inefficient "penny packets." The JFACC can optimize the use of space forces dedicated to the JFC when the forces are CHOPed.

The fork in the road is upon us and a decision is essential, which ensures space is not a different, difficult, and classified sideshow under the big tent of joint force employment. We should not draw back all space command and control into global operations centers due to the beliefs of some that "space is different" and "current C2 constructs won't work." The answer is to expand JWS to meet the needs of JFCs by providing dedicated and responsive on-orbit, near space, and deployable space capabilities as an organic part of JTFs. The benefits to our warfighting effectiveness and emerging warrior culture will be immeasurable.

Notes:

[1] AFDD 2-2, *Space Operations*, 27 November 2001, 23.

[2] Lt Col Brian E. Fredriksson, "Space Power in Joint Operations: Evolving Concepts," *Air and Space Power Journal* 18, no 2 (Summer 2004), n.p., on-line, Internet, 10 January 2005, available from http://www.airpower.maxwell.af.mil/airchronicles/apj/apj04/sum04/fredriksson.html.

[3] Adam J. Hebert, "Toward Supremacy in Space," *Air Force Magazine* 88, no. 1 (January 2005), n.p., on-line, Internet, 12 February 2005, available from http://www.afa.org/magazine/jan2005/0105space.asp.

[4] *Operating Concept for Joint Warfighting Space (JWS) (Draft)* 10 November 2004, 5.

[5] General Lance W. Lord, "Joint Warfighting Space Update," briefing, 21 December 2004.

[6] AFDD 2-2, 52.

[7] Maj Mark Main, "An Examination of Space Coordinating Authority (SCA) and Command Relationships for Space Forces" (unpublished paper, Fourteenth Air Force Weapons and Tactics Division, n.d.), 7.

[8] The personnel at CENTCOM Forward and in the CENTAF CAOC working deployable space force C2 were not invited/did not attend the USSTRATCOM and AFSPC/14 AF lessons learned conferences. The CENTAF conference included representation from 14 AF/AFSPC/deployed units. However, the representatives from 14 AF were not the primary interfaces with CENTAF during OIF. The primary interfaces were the 14 AF Strategy Division, Combat Plans Division and Combat Operations Division Chiefs, who did not attend.

[9] Joint Publication (JP) 0-2, *Unified Action Armed Forces*, 10 July 2001, III-9.

[10] Ibid., III-10.

[11] Fredriksson, 3.

[12] AFDD 2-6, *Air Mobility Operations*, 25 Jun 1999, 16.

[13] Operating Concept for JWS, 3.

[14] AFDD 2-2, 26.

[15] Hebert, n.p.

[16] Maj M. V. Smith, *Ten Propositions Regarding Spacepower*, Fairchild Paper (Maxwell AFB, Ala.: Air University Press, October 2002), 53.

[17] Major Samuel L. McNiel, "Proposed Tenets of Space Power: Six Enduring Truths," *Air and Space Power Journal* 18, no. 2 (Summer 2004), n.p., on-line, Internet, 10 January 2005, available from http://www.airpower.maxwell.af.mil/airchronicles/apj/apj04/sum04/mcniel.html.

[18] Operating Concept for JWS, 4.

[19] Smith, 54.

[20] Ibid., 54.

[21] Fredriksson, 3.

[22] General Richard B. Myers, *National Military Strategy of the United States of America*, 2004, 18. 1-4-2-1 is defend the homeland (#1), deter forward in and from 4 regions, conduct 2 overlapping "swift defeat" campaigns, and win 1 decisively.

[23] AFDD 1, *Air Force Basic Doctrine*, 17 November 2003, 3.

[24] Ibid., 3.

[25] AFDD 2-2, 24. The addition of [requirements] is based on the context of the preceding paragraph of the same section. "When the effect of employing space assets impacts national or multiple theater requirements, a centralized structure for command and control, maintained by USSTRATCOM is best."

[26] AFDD 2-2, 21.

[27] AFDD 2-2.1, *Counterspace*, 2 August 2004, ii.

[28] Doctrine Watch #3, *Operational Control (OPCON),* 4 November 1999, n.p., on-line, Internet, 25 January 2005, available from https://www.doctrine.af.mil/DoctrineWatch/DoctrineWatch.asp?Article=3.

[29] Author was USAFE Space Functional Area Manager.

[30] JP 0-2, xiii.

[31] AFDD 2-2, 28.

[32] AFSPC SMP, 23.

[33] MSgt Julie Briggs, "Near Space enhances joint warfighting", Air Force Print News, 18 February 2005, n.p., on-line, Internet, 25 February 2005, available from https://www.af.mil/news/story.asp?storyID=123009865.

[34] Operating Concept for JWS, 9.

[35] Ibid., 10.

[36] Ibid., 9.

[37] General John P. Jumper, "White Paper on Joint Warfighting Space," n.d, 2.

[38] AFSPC SMP, 23.

[39] JP 0-2, III-8.

[40] Operating Concept for JWS, 14.

[41] JP 0-2, III-10.

[42] Operating Concept for JWS, 2.

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Toward a Space Professional Reading List

Maj David C. Arnold
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General Ron Fogleman, former Chief of Staff (CSAF) created the Chief of Staff Professional Reading Program in 1996 to develop a common frame of reference among Air Force members -- officers, enlisted, and civilians -- to help each of us become better, more effective advocates of air and space power. Former CSAF General Michael E. Ryan and now General John P. Jumper have wholeheartedly embraced and continued the Professional Reading Program.[1]

The purpose of this article is to suggest a reading list aimed specifically at space professional development. This suggested reading list is particularly relevant as an outgrowth of the Report of the Commission to Assess United States National Security Space Management and Organization, commonly called the Space Commission, which highlighted the need for a space professional development program.[2] The collective abilities of our active, guard, reserve, and civilian space professionals provide our Nation a full spectrum of space capabilities that are second to none. This reading list is not an attempt to create a syllabus for a course in space power history, although they do exist. This list is intended to help sustain our space dominance and understand the world in which we operate. We must develop a wider perspective and an appreciation of views other than our own.[3]

Should other career fields have professional reading lists? Do rated officers need their own reading list? Maybe. The possibility, of course, is that civil engineers and doctors and security forces might need their own reading lists, too. But none of these career fields have had a National commission criticize its "limited experience among officers in the field" and failure to reach its potential.[4] For now, the Air Force does have the CSAF's reading list. General Jumper's list is subdivided into four areas: history of the Air Force from its beginning through its major transformations as an Institution; insight into ongoing conflicts and the frictions that can produce conflicts in the future; organization, leadership, and success stories holding lessons for the present and future; and lessons emerging from recent conflicts -- and the preparation for them.[5] Any Airman reading these books will have a better understanding of Air Force heritage and the world in which the Air Force operates today.

Army officers, by contrast, have a reading list that is subdivided by the stage of the reader's career: one for cadets and junior Soldiers; one for company grade officers and NCOs; one for field grade officers; and one for general officers.[6] According to Army Chief of Staff General Peter Schoomaker, "The Professional Reading List is a way for leaders at all levels to increase their understanding of [the] Army's history, the global strategic context, and the enduring lessons of war." Much like the Air Force's reading list, "the topics and time periods included in the books on this list are expansive and are intended to broaden each leader's knowledge and confidence."[7] These books are focused on the Army's mission of leading troops in combat on the battlefield. The Navy has two professional reading lists, a separate reading list for enlisted Sailors and officers.[8] The two Navy lists are similar in purpose to the Army's lists, focused on the Navy's mission of leading Sailors and Marines in a maritime environment.

What stands out among all of these reading lists is that there are no books devoted to the role that space plays in national defense. Therefore, although one will certainly benefit as a military professional, we cannot grow space professionals by reading the books on these lists. Bottom line, the fourth dimension of warfare needs its own reading list.

I have divided my suggested list into three basic areas. The basic categories are Space History, Space Policy, and Space Futures. These are not definitive areas, but they work for organizing my own professional reading. You will notice that the books are not exclusive to military space because the list includes books that deal with NASA, an important part of the wider space community. These are also not the definitive books on the subjects, but they will further you down the road towards your own space professional development. As you read, you will come across other books you may want to explore. (My own book is not on this list, but if you wish to read it, or you're interested in the history of satellite command and control in the Air Force, I won't stop you!)[9] Most of these books are not going to be available at your local library--your university libraries will have them, and the Air University library certainly has them--but they will be available at your favorite on-line bookseller either as new or used editions. Although the list does lean heavily in space history and space policy, it contains some books that are simply good reads and some that will challenge you intellectually. Most of these books were chosen because of their readability.

I encourage each of you to make time for professional reading as part of your continuing development as space professionals. Their selection does not reflect the CSAF's, Air Force Space Command's, or the Air Force's endorsement of the authors' views or interpretations.

Space History

Chaikin, Andrew. *A Man on the Moon: The Voyages of the Apollo Astronauts* (New York: Penguin Books, 1998).

Crouch, Tom D. *Aiming for the Stars: The Dreamers and Doers of the Space Age* (Washington: Smithsonian Institution

Press, 1997).

Day, Dwayne A., John M. Logsdon, and Brian Latell, eds. *Eye in the Sky: the Story of the CORONA Spy Satellites* (Washington: Smithsonian Institution Press, 1999).

McCurdy, Howard E. *Space and the American Imagination* (Washington: Smithsonian Institution Press, 1999).

McDougall, Walter A. *...the Heavens and the Earth: A Political History of the Space Age* (Baltimore: Johns Hopkins University Press, 1997).

Neufeld, Michael J. *The Rocket and the Reich: Peenemunde and the Coming of the Ballistic Missile Era* (Cambridge: Harvard University Press, 1996).

Siddiqi, Asif. *The Soviet Space Race With Apollo* (Tallahassee: University of Florida Press, 2003).

Spires, David N. *Beyond Horizons: A Half Century of Air Force Space Leadership,* Revised Edition (Maxwell AFB, Alabama: Air University Press, 1998).

Space Policy

Burrows, William E. *Deep Black: Space Espionage and National Security* (New York: Berkley Publishing Group, 1988).

Lambeth, Benjamin. *Mastering the Ultimate High Ground: Next Steps in the Military Uses of Space* (Washington, DC: Rand, 2003).

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Lambright, W. Henry, ed. *Space Policy in the 21st Century* (Baltimore: Johns Hopkins University Press, 2003).

Zubrin, Robert. *The Case for Mars: The Plan to Settle the Red Planet and Why We Must* (Boulder: Free Press, 1997).

Notes:

[1] "Air Force CSAF Professional Reading Program," on-line, Internet, 19 April 2005, available from http://www.af.mil/csafreading/background.asp.

[2] "Space Professional Update," on-line, Internet, 19 April 2005, available from https://halfway.peterson.af.mil/spacepro/Documents/STW%20Website_files/ frame.htm.

[3] "Air Force CSAF Professional Reading Program."

[4] "Report of the Commission to Assess United States National Security Space Management and Organization," 11 Jan 01, pp. 44-46.

[5] "CSAF's Reading List," on-line, Internet, 19 April 2005, available from http://www.af.mil/csafreading/.

[6] The Air Force used to subdivide its reading list this way--beginner, intermediate, and advanced--but went to a more topical list in 2002.

[7] "The US Army Chief of Staff's Professional Reading List," 23 Jul 04, on-line, Internet, 19 April 2005, available from http://www.army.mil/cmh-pg/reference/CSAList/CSAList.htm.

[8] "Enlisted Professional Reading List," 22 April 2005, on-line, Internet, 19 April 2005, available from http://www.chinfo.navy.mil/navpalib/mcpon/readgide2.html; "Suggested Books on Leadership and Management," 20 September 2004, on-line, Internet, 19 April 2005, available from http://www.chinfo.navy.mil/navpalib/cno/reading.html.

[9] David Christopher Arnold, *Spying from Space: Constructing America's Satellite Command and Control Networks* (College Station: Texas A&M University Press, 2005).

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Transforming Space Capabilities

Col John W. Raymond
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Force Transformation Office

Transformation is "a process that shapes the changing nature of military competition and cooperation through new combination of concepts, capabilities, people and organizations that exploit our nation's advantages and protect against our asymmetric vulnerabilities to sustain our strategic position which helps underpin peace and stability in the world."

- Department of Defense
Transformation Planning Guidance

The United States space capabilities feature prominently in the global advantages currently enjoyed by this Nation, while serving as the critical strands of DNA that are driving the Department of Defense's transformation strategy. The most significant transformation that the Department faces is the shift from the industrial age to the information age, and importantly this strategic shift has largely been enabled by on-orbit space capabilities.[1]

Just as the sea was a "strategic common" in the industrial age, space and cyberspace must be added to the list in the information age. The reason is that nations with great power aspirations must be able to operate in and control the strategic commons. Therefore, it should come as no surprise that the United States can expect to be militarily challenged in these areas.

Moreover, it should be no surprise that when the President and Secretary of Defense raised transformation to the level of national strategy by imbedding it in the National Security Strategy and Defense Strategy, enhancing the capability and survivability of space systems and the supporting infrastructure was one of six operational goals identified to provide focus for DOD's transformation efforts.[2]

Three Phases of Space Transformation. When writing about transforming space capabilities, one must start by recognizing the significant transformation that has already occurred in the forty-five years since the Air Force launched its first satellite into space.

PHASE 1: ESTABLISHING GLOBAL UTILITIES (1958-1991)

The United States' National Security space team has made great strides in its 50 year history. Established during the height of the Cold War, the National Security space program quickly became a new source of *national* power. There was a clear connection between space and the strategic deterrent forces. The US used converted weapon systems to rapidly develop the ability to launch small payloads into low earth orbit, graduating over time to larger payloads in higher orbits that proved vital for detecting the ballistic missile threat posed by the Soviet Union. The United States spent the first three decades of its National Security space program developing and launching constellations of satellites, effectively blanketing the globe with "space utilities."

PHASE 2: THEATER DISTRIBUTION OF SPACE UTILITIES (1991-2000)

Operation DESERT STORM, which many deemed the first space war, highlighted the importance of being able to distribute global space utilities in the theater, thereby increasing its relevance to the theater commander. Space forces, like traditional military forces, used a robust Cold War force structure as part of the Coalition effort to defeat the Iraqi armed forces and expel them from Kuwait. During the decades of the 1990s, the National Security space focus shifted towards "operationalizing" or "normalizing" space to make this theater-level focus more permanent. This shift was cemented when the Air Force named General Chuck Horner, the Joint Air Force Component commander in Operation DESERT STORM, the new commander of Air Force Space Command.

The Command's strategic focus shifted towards an operational level of war mindset. In the early 1990's, the Air Force activated the 14th Air Force to provide operational command and control over all Air Force space capabilities. Additionally, the Air Force stood up the Space Warfare Center, the 76th Space Operations Squadron to provide deployable Space Support Teams directly to theater, 11th Space Warning Squadron, and the Space Division at the USAF Weapons School-- all focused

"We've spent between thirty-five and forty billion dollars on space…but if nothing else had come from that program except the knowledge that we get from our satellite photography, it would be worth ten times to us what the whole program has cost. Because tonight I know how many missiles the enemy has…our guesses were way off."

- President Lyndon B. Johnson, 1967

on operationalizing or distributing space utilities to and within a joint theater.

A good example of transforming strategic Cold War space utilities into capabilities with theater warfighting relevance is using the Defense Support Programs (DSP) for theater warning. During Desert Storm, innovative space professionals developed enhanced stereo processing of strategic warning data to provide the rudimentary theater ballistic missile warning capability to Coalition forces so that they could shield themselves from the Iraqi Scud missile threat. In the decade following Desert Storm, the Air Force significantly improved on the innovative system used in 1991 through technological advances in ground processing, the creation of a new organization (the 11th Space Warning Squadron) to focus on theater warning, and the establishment of new command and control relationships to provide warning directly to the joint force commander. In addition, the Air Force implemented a new concept of operations to provide assured warning vice the near perfect warning mandated by the strategic warning mission, and most recently activated the space-based infrared system ground station-- enhancing the theater warning capability even more.

"One doesn't have to be a space power to employ space power."

Enhanced theater missile warning is just one example of how innovative space professionals have enhanced the theater relevance of strategic capabilities. One need only compare Operation DESERT STORM with Operation ENDURING FREEDOM (OEF) or Operation IRAQI FREEDOM (OIF) to see how successful the United States has been at "operationalizing" its global space forces.

One of the dramatic differences between Operation DESERT STORM and OIF was the distribution of satellite-based wideband communications down to the tactical level. In Operation DESERT STORM, Coalition military forces numbered 542,000 and had 99 megabits per second of bandwidth available. In OEF/OIF, bandwidth rose to 3,200 megabits per second, over 80 percent provided by commercial communications satellites, while forces were reduced to 350,000.[3] Satellite communications provided the backbone for blue force tracking, shared situation awareness down to the *individual level*, and allowed operational and tactical level commanders to exploit an unprecedented speed of command.

In the years leading up to OIF, the United States made great advances in developing and fielding weapons that could tap the potential of the Global Positioning System. Existing laser-guided bombs were complemented by the Joint Direct Attack Munition (JDAM) and other guided weapons. This improvement in weaponry has significantly increased our precision strike capability while lowering its cost.

Finally, the joint forces commander also benefited from significant doctrinal advances. During OIF, the Joint Force Air Component Commander was designated the Space Coordinating Authority, and Brigadier General Larry James was designated the Senior Space Officer to help coordinate space activities across the area of responsibility (AOR) and to ensure integration into the theater air, land, and maritime operations. Today, the senior space officer in theater is called the DIRSPACEFOR. Because of the inherent jointness of space capabilities, the DIRSPACEFOR position is evolving into a Joint position.

These examples of increased bandwidth, refined theater missile warning capability, enhanced precision and maturing doctrine illustrate just how successful innovative space professionals have been at transforming global space capabilities for theater relevance. As General (Retired) Tommy Franks, USA, the Joint Forces commander in OEF, articulated in his testimony to Congress: "the pieces of this operation which have been successful would not have been so without space-based assets. It's just very simply a fact."[4] This transformation of space capabilities has fundamentally transformed both the operational and tactical level of war. In OIF, the Nation's space capabilities directly impacted speed of maneuver, the tempo of the fight, and the boldness and lethality of coalition forces.

PHASE 3: SPACE SUPERIORITY (2001-PRESENT)

Due in large part to the success space professionals have had at operationalizing global space capabilities, the United States and its Coalition partners enjoy a significant asymmetrical warfighting advantage.[5] However, this same asymmetrical advantage, exploited by an enemy, can quickly turn into an asymmetric vulnerability. Several key trends in space heighten the need to control space. These trends include:

Falling Barriers to Entry. The barriers for entry into space, which were so high during the Cold War, have eroded due to technological advances. No longer is space reserved for super power nations alone. The emerging small satellite market and the existing commercial space segment now allow third world countries, non-state actors and individuals to tap into the power derived from space.

Increasing Dependency on Space Capabilities. The United States is the most heavily space-dependent nation in the world. Likewise, the United States military forces are the most heavily space dependent. As the transformation from an industrial base force to an information age force progresses, there are clear indications that this dependency will only increase.

Information Age Technology. Space technology itself is also undergoing rapid change. Today, small satellites provide less performance in areas like resolution, power, and persistence. However, small satellites can provide great advantages in operational control, integration, responsiveness, agility, cost, risk, and information sharing among coalition partners. While the cost to place a kilogram of capability on orbit remains expensive, the capability resident in every kilogram is soaring.

At the intersection of these three trends -- falling barriers to entry, increased dependency and a new technology context es-

tablish the foundation for the emergence of new military competitive arenas in space.[6] The door for small, micro and nanosatellites is opening. No longer is the small class of satellites relegated to university experimentation; this emerging niche now offers potentially significant military capability. However, the United States, clearly the world's leader in space, has abdicated to other nations a role in exploiting these smaller segments of the overall space industry.

Operationally Responsive Space Business Model. At the threshold of transforming to a network centric force, the Department of Defense is using distributed military forces and systems to achieve commander's intent of newer, smaller elements of space capability, which are part of an emerging toolset with great potential. The Department of Defense is now exploring a broader business model for space. This business model, which is called Operationally Responsive Space, seeks to capitalize on the emerging small satellite market to redefine the cost, agility, mission criticality and risk calculus of space systems while increasing transaction and learning rates.

"If we lose the low end today, we could lose the high end."
- Andy Grove, Former Intel CEO

Rather than operationalizing global space capabilities, this Operationally Responsive Space model seeks to custom build space systems with the attributes desired by the theater-level joint force commander. Operationally Responsive Space seeks to complement, not replace, current large space programs. Today, small satellites cannot provide the same level of capability that larger satellites currently provide. However, just as the Department of Defense has operationalized the larger space program to meet theater needs, these custom-designed theater capabilities will also enhance our National and strategic space capabilities. Specifically, these satellites will help reduce the burden currently placed on our National systems and the organizations that operate them, enhance the persistence of national capabilities, assist in meeting force structure requirements mandated by current force planning constructs, and help ensure that US forces are adaptable while facing an uncertain future. Rather than competing on technical superiority, the Operationally Responsive Space business model adopts the metrics of speed, agility, customization, and flexibility.

Another role these systems will provide in the future is the ability to reconstitute larger space capabilities if adversaries succeed in developing capabilities to negate them. Although it is not replenishment in kind, smaller satellites could provide a subset of capabilities for national and military leaders. Over time, as both technology and the concept of operations for small satellites mature, the gap between traditional space and smaller space capabilities will narrow.

Finally, the small satellite segment can serve as a test bed for the larger National military space program by enabling a generational development and acquisition strategy. It affords the opportunity to increase the number of science and technology payloads making it to space, enhance the spiral development of on-orbit space capabilities, enable faster technology refresh, grow concept of operations in parallel by utilizing a robust joint experimentation program, and professionally develop space professionals in the military, industry and academia. In short, it is within the United States' grasp to create new options in space, a process which itself can offer a very powerful competitive advantage.

Transitioning from Experimentation to an Operational Warfighting Capability. Currently, the Department of Defense has a series of TacSat and Joint Warfighting Space experiments planned to explore alternative futures. These experiments are designed to incrementally enhance the key Operational Responsive Space system elements to achieve the agility necessary to be operationally relevant. These elements include Operationally Responsive Spacelift, satellite and payload command and control, modular satellite busses with standard payload interfaces, and innovative low cost payloads. Several critical next steps include:

Joint Concept of Operation. The Air Force is currently leading the development of a Concept of Operation called Joint Warfighting Space. The Joint Warfighting Space concept consolidates both responsive orbital space and near space segments. Over the next year this concept will be refined and vetted through the Joint Capability Integration and Development Process.

Modular Satellite Buses. The Office of Secretary of Defense Force Transformation Office and the Space and Missile Systems Center are leading a broad National team to develop a Joint Warfighting Space satellite bus with standard payload interfaces. This is an important mechanism to increase agility while decreasing cost and risk. The goal is to turn the satellite bus into a commodity and shift the focus of our national and service laboratories to developing payloads consistent with the core competencies of the organizations they represent.

Low Cost Launch. A critical aspect of Operationally Responsive Space is low cost responsive and assured launch. There are several small launch vehicles being developed as part of the joint Air Force and DARPA Falcon Program. The goal of the program is to launch 1000 lbs into Low Earth Orbit for approximately $5 million. The realization of this goal will facilitate the implementation of the broader business model.

Systems Engineering of Tiered Capabilities. The National Security Space Office is currently leading an effort to develop a National Security Space architecture that includes a complementary and integrated Responsive Space segment. In a network centric force, each satellite becomes a node within a tiered network of sensors such as larger space systems, near space, unmanned aerial vehicles, or other air and surface assets. The next step is to accomplish the system engineering of this tiered, integrated system.

The Department of Defense is currently exploring new and broader, and complementary business model called Operationally Responsive Space.

Innovation in technology, process, organization and, most importantly, people is the foundation for transformational capabilities.[7] Innovative space professionals have made significant advances in all four areas, and have been successful in transforming global space utilities into theater relevant capabilities. In doing so, space capabilities have served as the revolutionary DNA for the most significant transformation facing the Department of Defense, which is the shift from the industrial age to the information age. US space capabilities directly impact the speed of maneuver, tempo of the fight, and boldness and lethality of today's joint warfighting force. Future capabilities provided by the Transformation Communications Satellite, Space-Based Infrared System and Space Radar will bring these joint force attributes to even greater levels.

However, the intersection of several key trends-- lowering of the barriers of entry into space, increased reliance on space, and a changing technology context-- lays the foundation for new arenas for military competition. The Department of Defense is currently exploring new and broader, and complementary business model called Operationally Responsive Space. Today's strategic context demands that the DoD undertake actions that are swift, bold and very specific. Operationally Responsive Space clearly meets those criteria. As the major military power in the world today, the United States must continue to compete for those space advantages to ensure its National Security.

Notes:

[1] Lieutenant General Arthur K. Cebrowski, Director, Office of Secretary of Defense Force Transformation. Address. National Defense University, Washington, D.C., 31 January 2002.

[2] *Quadrennial Defense Review Report*. US Government Report. Washington, D.C.: Department of Defense, September 2001.

[3] Lt Gen Robert M. Shea. "Industry Advisory Council Brief." Directorate for Command, Control, Communications, and Computer Systems (J6).

[4] General T. Michael Moseley, USAF Vice Chief of Staff, letter to *US News and World Report*, 2 September 2003, on-line, Internet, available from http://www.nro.mil/PressReleases/prs_rel71.html.

[5] General Lance W. Lord, Commander, Air Force Space Command, address to 19th National Space Symposium, Colorado Springs, Colo., 8 April 2003.

[6] Department of Defense Publication. Military Transformation A Strategic Approach, Fall 2003.

[7] John J. Garstka, "The Transformation Challenge," *NATO Review*, Spring 2005, on-line, Internet, 14 April 2005, available from http://www.nato.int/docu/review/2005/issue1/English/special.html.

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Powered Spaceflight for Responsive Space Systems

Lt Col Robert D. Newberry
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Space and Missile Systems Center (SMC)

Since the conclusion of the Commission to Assess United States National Security Space Management and Organization (also known as the Space Commission), there has been a growing interest within the Defense Department for developing responsive space systems. Although the Space Commission report did not use the term 'responsive space,' it did highlight the need for many elements of a responsive space force structure. This is seen in statements such as recommending a "shift from hand-tooled, custom-built space hardware to an infrastructure based on standardized hardware and software."[1] Earlier Air Force responsive space activities had adopted the term "Operationally Responsive Space" (ORS) which focused on developing new launch capabilities to deploy satellites in days or weeks from call-up. The ORS Program has become closely tied to the joint Air Force and Defense Advanced Research Projects Agency (DARPA) Program called Force Application and Launch from CONUS (FALCON). The Air Force funding for FALCON has been programmed in the Operationally Responsive Launch (ORL) Program Element (PE) but has not included the development of spacecraft beyond demonstration work on the Common Aero Vehicle (CAV).

The primary application to consider for a conjunction spacecraft is to provide taskable space support to tactical forces. This leads to the concept of powered spaceflight.

Subsequent to the Space Commission, the term "responsive space" had become more widely used instead of ORS. This shift in terminology has signaled a shift from a solution-oriented approach to a capabilities-based approach where the performance of the system is intended to respond to new taskings within days, hours or minutes without conceptually proscribing how it is done. In March 2004, the Chief of Staff of the Air Force, General John P. Jumper, initiated the Joint Warfighting Space (JWS) Concept as a manifestation of a responsive space program. JWS focuses on tactical- and operational-level effects to support combatant commanders as the highest priority for responsive space systems. In the summer 2004, Congress continued its participation in the discussion by funding an additional twenty million dollars to the Fiscal Year 2005 (FY05) defense budget for the research, development, test and evaluation (RDT&E) of operationally responsive spacecraft.[2] Congress also signaled its commitment to the original ORS moniker by providing its definition of "operationally responsive space" in the FY05 National Defense Authorization Act (H.R.4200):

> "(c) DEFINITION OF OPERATIONALLY RESPONSIVE- In this section, the term 'operationally responsive', with respect to a national security payload and bus for a space satellite, means an experimental or operational payload and bus with a weight not in excess of 5,000 pounds that—
>
> (1) can be developed and acquired within 18 months after authority to proceed with development is granted; and
>
> (2) is responsive to requirements for capabilities at the operational and tactical levels of warfare."[3]

The Bush Administration has demonstrated its support for responsive space in the 6 January 2005 US Space Transportation Policy. This policy statement calls for the Secretary of Defense to "develop the requirements and concept of operations for launch vehicles, infrastructure, and spacecraft to provide operationally responsive access to and use of space…"[4] While the responsive space, ORS and JWS concepts are not new, what is new is the increased emphasis from the President, Congress, Secretary of Defense (OSD), and the Air Force senior leadership. Even though there have not been significant funding commitments for responsive space, it seems that resources are bound to follow since the concept has such broad support and appeal.

There has been a significant amount of analysis and development for many elements of the emerging responsive space architecture. Most notable of these is the FALCON program with its development of low cost launchers. The spacecraft development for responsive space lags significantly behind the launcher work as fewer resources have been devoted to this area and the FY05 Congressional add was intended to address this shortfall. Most of the prior work had been re-using residual spacecraft hardware and science and technology (S&T) funds, such as the OSD-sponsored tactical satellite (TacSat) program, instead of creating a developmental program. Although the Air Force has now incorporated its TacSat participation as part of the JWS concept, it is still only investing S&T funds for spacecraft development. The most significant missing piece of the responsive space puzzle will continue to be the spacecraft for the foreseeable future.

The current responsive spacecraft developments are an extension of the original OSD TacSat initiative where the objective is to spend a minimal amount of funds and time in the development of the spacecraft. The funding constraints for developing responsive spacecraft has caused the current program

to simply be a small-scale version of the larger space programs. The current approach to spaceflight was adopted decades ago as a result of the initial space exploration program. Unless the responsive space program can adopt fundamentally new ways of performing space missions, the utility of the new space systems will simply mirror the "faster, better, cheaper" or "do more with less" slogans of the past. The most urgent need is to transform the very essence of the military space program so that it is operationally responsive by design and not by simply working harder with the existing tools and operational concepts.

The realm of the possible for new space systems is an unbounded menu of options limited only by one's imagination. The usual fare of orbits, such as sun-synchronous or geo-synchronous, should not constrain the consideration of new ways to conduct space missions. The Space Commission appropriately noted that "mastering near-earth space operations is still in its early stages."[5] It is interesting to note that while the US has a technological edge in space systems, it has not been as aggressive in adopting new ways of conducting space operations as our peer competitors. Arthur C. Clarke, a British citizen, was the conceptual originator of geo-synchronous obits and the Soviet Union took critically-inclined orbits from theory to reality with the introduction of the molniya orbit.[6] The US has generally followed others in the operational approach to space systems while priding itself in the higher technical quality of its systems. It would be difficult to proscribe the entire range of possible future space systems but it would be beneficial to describe a new class of spacecraft to illustrate the point that new operational approaches to space are warranted.

To date, the US has developed and fielded space systems that can be grouped into two categories. There is not an established taxonomy for these categories but the terms rendezvous and re-entry seem to be good characterizations of these systems. Rendezvous systems are those that are launched into a relatively stable orbit. Orbit stability is achieved by being inertially stable or precessing at a desired rate such as a sun-synchronous orbit. Orbit perturbations, such as the rotation of the argument of perigee are generally eliminated by having near-circular orbits.

The spacecraft is intended to rendezvous at this orbital state--then the position is maintained through station keeping. This has resulted in the overwhelming dominance of unpowered spaceflight since the spacecraft is only intended to maintain "wings level flight." While these systems can be repositioned to other orbital states, they are designed around the assumption that spacecraft operations will occur while parked in its rendezvous position. Re-entry systems are those that are intended to transit space as a medium from which to deposit energy or material from space to the earth. Intercontinental Ballistic Missiles (ICBMs) are an obvious example of re-entry systems. The US military space program makes nearly exclusive use of these orbit categories with most orbits being near-circular or critically-inclined so that their inertial state is known and can be forecast far into the future. Now that responsive space has emerged as a possible future paradigm, one should consider whether these orbit regimes will be sufficient or if an entirely new class of orbits should be considered. The one discussed here could appropriately be called conjunction systems.

A conjunction space system is one that is not critically-inclined and elliptical so the rotation of the argument of perigee is a significant feature of the orbit. While this represents the vast majority of possible orbital states, these orbits have generally been avoided because they are not widely suitable for the strategic missions the space program initially adopted. The most significant barrier to using these orbits for global utility-type missions is that the distance above the ground cannot be easily controlled.[7] This makes them undesirable for photo reconnaissance of the ground.

The term conjunction is derived from the rotation of the orbit where the surface of the orbital plane will intersect with the surface of the other orbital planes within its altitude regime. Every time the two orbital plane surfaces are aligned, the spacecraft could potentially collide by arriving there at the same time. While this represents a potential hazard to spaceflight, it also opens the opportunity to track, inspect or assess other space objects with few constraints. This capability could perform meaningful support to assessing the status of other high value space objects such as shuttles and the international space station (ISS). Such a capability could address the findings of the Columbia Accident Investigation Board (CAIB) for imagery of space objects and is depicted in figure 1.[8] Since rendezvous orbits are the current reference point for thinking about space operations, this class of operations seem appropriate to be categorized as conjunction orbits.

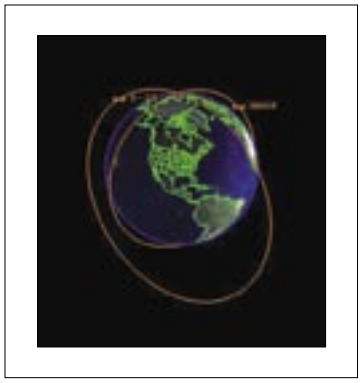

Figure 1. Orbit Conjunction With the Defense Meteorological Satellite Program.

The primary application to consider for a conjunction spacecraft is to provide taskable space support to tactical forces. This leads to the concept of powered spaceflight. If one knows the geographic region their forces will be operating in, then they can tailor conjunction orbits in such a way as to give them control of time-over-target (TOT) and do it in an unwarned manner. For simplicity, this paper describes one such powered spaceflight option to illustrate the concept. The basic idea is to select an orbit whose period is an odd divisor of 24 hours to ensure the spacecraft overflies the same longitude twice a day. A second consideration for orbit selection is to make the orbit highly elliptical to allow for faster maneuver rates with low fuel usage. If one assumes a typical small spacecraft weight of 500 Kg and using a Minotaur IV launch vehicle, then an orbit period of 2.7 hours can be achieved (i.e., 24 hours divided by nine). The ground track for such an orbit that is inclined 85 degrees is shown in

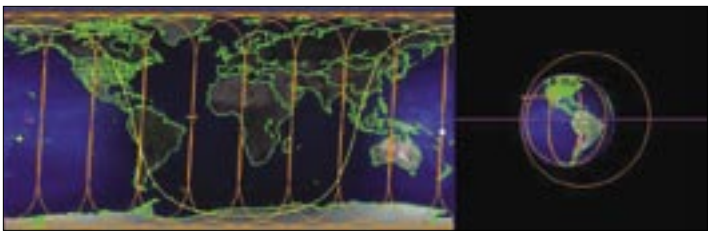

Figure 2. Ground Tracks With Orbit Oriented to Equator.

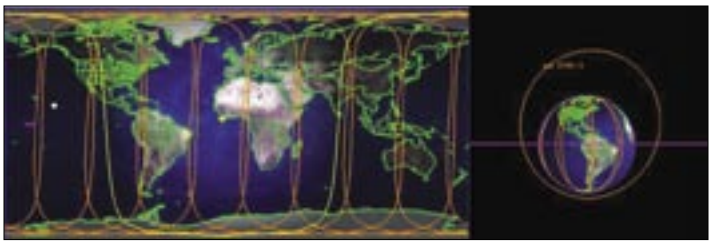

Figure 3. Ground Tracks When Orbit Rotates Over North Pole.

figures 2 and 3. Such an orbit will overfly the theater twice a day while "walking" left and right over the centerline longitude. This provides the baseline orbit from which to control TOT.

Spacecraft maneuvers are generally avoided for rendezvous spacecraft since they can quickly shorten the lifespan of the craft. This is because circular orbits are the least fuel efficient orbits to "move" in space. By operating in highly elliptical orbits, one can make orbit adjustments with a few tens-of-meters-per-second thrusts to control TOT. Figure 4 shows how much fuel, in meters-per-second, it takes to adjust TOT based on a three-day lead-time for the tasking. Two thruster systems are plotted to show the relative difference between high- and low-thrust systems. Low thrust systems are particularly attractive for conjunction spacecraft since they can increase the total amount of possible orbit adjustments, or gas mileage, by five or six times. A fuel budget of 3,000 meters-per-second can be achieved by such a system. Although a low thrust system reduces system TOT responsiveness by about 10 percent, the five times increase in total fuel budget warrants such a trade off.

As seen in figure 4, the low thrust system has a right limit line of 1.8 hours for how much later it can arrive within view of the support point over a three- day period. This is the best

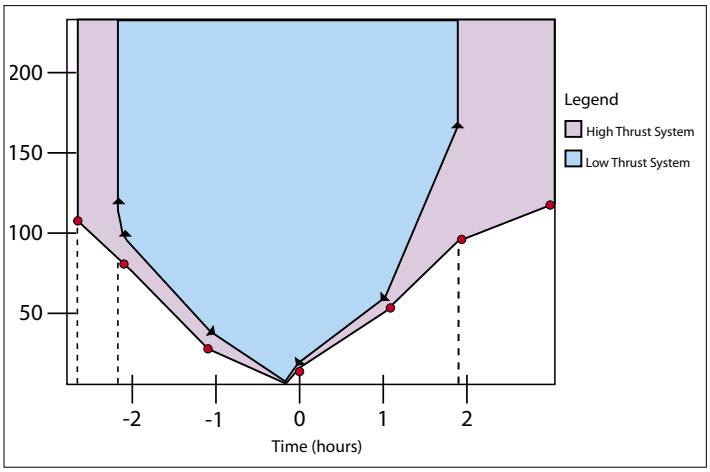

Figure 4. Time Over Target Control.

performance the spacecraft can achieve if the thrusters are operated nearly-continuously from maneuver initiation. The left dashed limit lines show the limit of adjusting the orbit to an earlier TOT based on keeping perigee above 100 miles in altitude. Should the spacecraft attempt to arrive earlier than this, it will experience undesirable atmospheric effects or impact the earth.*

Another way to plot spacecraft performance is to show TOT control based on the number of days lead time for the tasking. Given a week lead time, then any TOT can be achieved. Figure 5 shows the range of arrival times available for three, four and seven days of lead-time. The figure shows the asymmetry in TOT performance that favors later arrivals due to the earth-impacting limit line on the right side of figure 4.

A conjunction spacecraft should find a wide range of applications to conduct missions in the radio frequency (RF) spectrum. The TOT control offered make them especially valuable for tactical signals intelligence (SIGINT) for geo-location of emitters, data exfiltration, low probability of intercept (LPI)

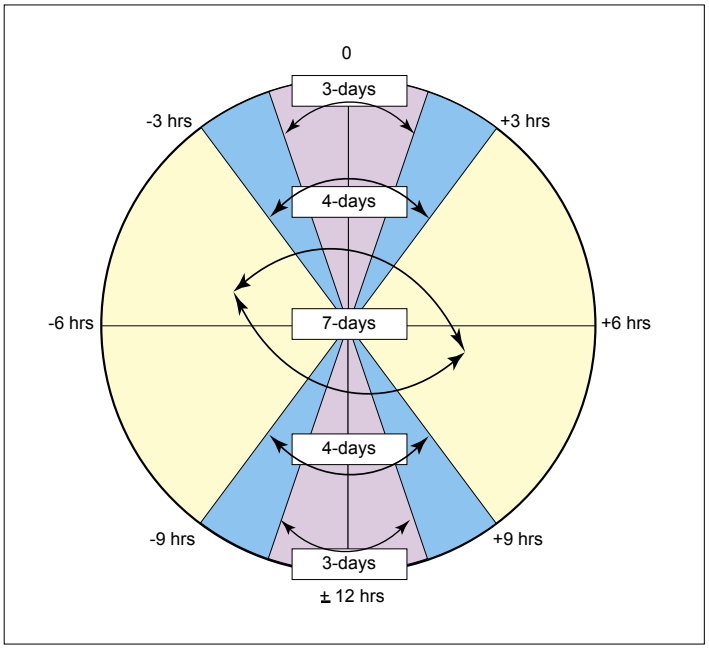

Figure 5. TOT Performance Based on Lead Time.

communications, and several information operations to include network mapping and electronic warfare. They would be useful for blue force tracking, battlespace surveillance, and a wide variety of RDT&E programs as a part of a spiral development program. The opportunities for advanced spaceflight training, concept of operations (CONOPS) and tactics, techniques, and procedures (TTP) development, space range, and experimentation merit serious consideration. Additionally, the space-to-space opportunities for satellite imagery and space situation awareness should contribute greatly to the space control mission. A platform with such a wide range of capabilities enables an aircraft-like approach to space operations where the platform and flight controls remain stable while each tail number is tailored for a particular mission. Also, the maneuvering aspects of TOT control make space operations more closely mirror air operations with the operators flying sorties-in-space.

It appears the current emphasis on responsive space systems offers the Air Force an opportunity to develop a fundamentally new class of spacecraft whose operations would blend the rich Air Force heritage with air operations and the legacy space systems.

It appears the current emphasis on responsive space systems offers the Air Force an opportunity to develop a fundamentally new class of spacecraft whose operations would blend the rich Air Force heritage with air operations and the legacy space systems. Such a development seems inevitable in the evolution of spacepower as there appears to be limited room for improvement with the existing suite of rendezvous orbits.

Notes:

[1] Commission to Assess United States National Security Space Management and Organization (i.e. Space Commission), report, 11 January 2001, 41, on-line, Internet, available from http://www.defenselink.mil/pubs/space20010111.html.

[2] House Report 108-767, Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Title II, Research, Development, Test and Evaluation, Defense-Wide, on-line, Internet, available from http://thomas.loc.gov.

[3] H.R.4200, Title IX, Subtitle B, section 2273a, on-line, Internet, available from http://thomas.loc.gov.

[4] US Space Transportation Policy, 6 January 2005, para 5.a, on-line, Internet, available from http://www.ostp.gov/html/SpaceTransFactSheet-Jan2005.pdf.

[5] Space Commission Report, 17.

[6] Arthur C. Clarke is credited for first conceiving of geo-synchronous satellites with his 1945 article in *Wireless World*.

[7] Viewing space systems as global utilities is discussed by Lt Gen Bruce Carlson, *Defending Space-Based Global Utilities*, Aerospace Power Journal, Summer 2000, on-line, Internet, available from http://www.airpower.maxwell.af.mil/airchronicles/apj/apj00/sum00/carlson.html.

[8] The CAIB Report, volume 1, 26 August 2003, 37, on-line, Internet, available from http://www.caib.us/.

*The spacecraft will arrive earlier or later to the Right Ascension of the Ascending Node (RAAN) based on figure 4. This does not mean it will not pass directly over the support point. The viewing angle to the support point will depend on the spacecraft's altitude and the time differential relative to the RAAN.

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He received his commission upon graduation from the US Air Force Academy in 1986 where he earned a Bachelor of Science Degree in Electrical Engineering. At the University of Southern California, he earned a Master of Science Degree in Electrical Engineering in 1992, and at the Air War College, he earned a Masters Degree in Strategic Studies in 2003. Colonel Newberry has completed Squadron Officer School, Air Command and Staff College, Defense Systems Management College, Joint Forces Staff College, and Air War College.

TSAT: Transforming C4ISR through Space Communications - Decision Superiority

Troy E. Meink
TSAT Program Manager
Glen E. Elfers
Senior Project Engineer

In recent comments, the former Under Secretary of the Air Force, Peter B. Teets, said that the use of space command and control, communications, computers and intelligence, surveillance and reconnaissance is providing joint forces "persistent situation awareness" like never before. This gives combatant commanders fast and reliable decision-quality information.[1] Military satellite communications (MILSATCOM) provides the space communications part of the equation to enable persistent situation awareness. With MILSATCOM, joint forces can take advantage of superior communications to quickly move situation awareness information that then creates superior knowledge to achieve 'decision superiority.' In other words, "better decisions arrived at and implemented faster than an opponent can react, or in a noncombat situation, at a tempo that allows the force to shape the situation or react to changes and accomplish its mission."[2] In the next decade, the Transformational Satellite Communications System (TSAT) will provide the necessary leap forward to bolster space communications capability to meet rapidly rising user demands for space communications. Using TSAT, warfighters will be able to connect into the Global Information Grid (GIG) with small terminals at high data rates to receive critical intelligence, surveillance, and reconnaissance (ISR) information. In the network-centric environment facilitated by TSAT, each user on the network becomes capable of being both a consumer and provider of value-added information. Real-time development of situation awareness information helps ensure that our forces operate within the decision cycle of the enemy.

The Roots of Transformation

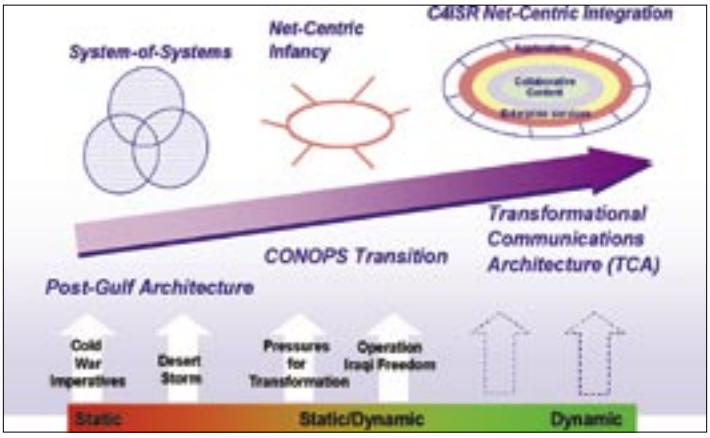
TSAT has its secure, jam-resistant heritage in MILSTAR and Advanced EHF (AEHF) satellites, and its high capacity heritage in the Defense Satellite Communications System (DSCS) and Wideband Gapfiller Satellites (WGS).

MILSTAR and AEHF address the protected satellite communications requirements of the military and National Command Authorities. Protected systems have the ability to avoid, prevent, negate, or mitigate the degradation, disruption, denial, unauthorized access, or exploitation of communications services by adversaries or the environment. In 2004, the MILSTAR Program was awarded the prestigious 2004 National Air and Space Museum Trophy for Current Achievement in recognition of the introduction of a highly advanced secure, cross-linked, global communications ability without the heretofore required dependency on regional ground-based relay stations. MILSTAR was a remarkable success story during Operation IRAQI FREEDOM (OIF), and was dubbed the "workhorse of the war" for its use in the coordination of ground forces moving into Baghdad, the movement of Air Tasking Orders and other critical communication functions.[3] AEHF will build on the MILSTAR foundation, and each AEHF satellite, when launched later in this decade, will provide 10 times greater capacity than that of the current MILSTAR satellites. Beyond MILSTAR and AEHF

DSCS has distinguished itself in the support to Operation ENDURING FREEDOM (OEF) and OIF, providing high capacity communications to large terminals and enabling commanders to establish voice and data communications between the theater and external networks. WGS will improve on the fixed service strongpoint of DSCS by an overall factor of 10, and provide Ka-band communications in addition to X-band.

In many respects, TSAT will be an evolution of both the protected and wideband systems. It will provide data rates historically associated with wideband systems, but with the security of protected systems. What makes TSAT transformational is the delivery of those capabilities in an Internet like, network-centric environment.

This vision for satellite communications grew out of the



The transformation to Network-Centric Operations and associated development of the Transformational Communications Architecture by the US Government SATCOM community led to the decision to acquire the Transformational Satellite Communications Satellite System.

DoD recognition that the vision for network-centric warfare would require a new form of communications infrastructure, referred to as the GIG, and this infrastructure must include an Internet Protocol based space transport layer -- TSAT. Emerging requirements included providing extremely high data rate unmanned aerial vehicle (UAV) communications services, communications for forces on the move, and providing increased connectivity to more users. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD/AT&L) directed

the National Security Space Architect to conduct an Analysis of Alternatives resulting in the Transformational Communications Study (TCS). This study recommended that a space-based communications network be established among the US Government SATCOM systems. As a result, in 2002, the former Under Secretary of the Air Force, Mr. Peter Teets, created the Transformational Communications Office; now the Communications Functional Integration Office under the National Security Space Office. This office was made responsible for providing governance, and was focused on cross-community interfaces, that were captured in the Transformational Communications Architecture (TCA) – within which TSAT is the DoD SATCOM element.

The TCA outlines a TSAT Program that will provide unprecedented satellite communications with Internet-like capability that extends the GIG to deployed/mobile users worldwide; providing increased situation awareness and targeting information to the warfighter.

Internet In The Sky

Network-centric interoperability is mandatory for TSAT. General Lance W. Lord remarked that "TSAT is the cornerstone of the Department of Defense's transformational network-centric communications architecture. The program is the foundation for our 'Internet in the Sky.'"[4] The network component of TSAT is unique in SATCOM and has many parallels with packet switched GIG terrestrial communications. The internet protocol (IP) based routers aboard the TSAT satellites are nodes on the larger GIG. The network aspects of TSAT are managed through the TSAT Mission Operations System (TMOS). The TMOS Segment consists of two elements--a network operations element and an operations management element. The network operations element provides the real-time and near real-time services necessary to manage the operation and configuration of the TSAT-related network. This element has the management capabilities of a typical terrestrial network operations center, but with the addition of satellite network resource management functions implemented in accordance with warfighter policy. The goal is to provide a control system capable of supporting the very dynamic data rates of battlefield communications needs and allow rapid redistribution of resources based on the warfighter requirements. The operations management element provides the capability for the long-term policy, network management and operational planning functions. These operational management functions roughly equate with those performed at Satellite Support Centers today. TMOS may be implemented at a central location or geographically distributed based on user requirements.

The TSAT Space Segment will deliver improvements in connectivity, capacity, interoperability, availability, security, and speed. For example, a TSAT user can connect at 1.5 Mega-bits-per-second using a one-foot antenna. Where feasible the burden is placed on the satellite, for example, in employing large satellite antennas to allow users to connect at high rates with smaller user antennas. This reduction in user terminal antenna size provides communications on the move (COTM) capability for more maneuverable and lethal forces. The higher protected data rates provided by TSAT will significantly decrease the time required to send and receive vital information. Airborne and space-based ISR assets will also be supported at high data rates using RF and laser links, which will help ensure that information needed for decision making is rapidly distributed.

In order to deliver this transformation in capability, the TSAT Program has structured a rigorous systems definition and risk reduction phase. The primary focus is to develop a detailed system design that is affordable and meets warfighter requirements, and to mature the technologies needed to support those designs. This will ensure the follow-on production phase goes smoothly, allowing on-time delivery of capability to the warfighter. One of the key areas of development is the onboard processor/router, which will ensure the efficiencies and connectivity of an IP packet switched network are built into each TSAT satellite. The processor/router also incorporates enhanced RF waveforms that improve overall bandwidth efficiency and provide link performance well beyond that established for AEHF. In addition to these developments, two other key technologies are needed for TSAT, laser communications and dynamic bandwidth resource allocation.

Laser communications has matured from concept demonstration to the engineering development phase and provides a step increase in bandwidth available to and from airborne intelligence, surveillance, and reconnaissance (AISR) platforms. Laser communications technology was demonstrated on orbit as part of the GeoLITE experiment, which was highly successful. The remaining challenge is to complete the qualification needed to demonstrate the life expectancy and reliability required for an operational system. Once operational, TSAT laser crosslinks will pass 10's of Giga-bits-per-second (Gbps) between satellites, and laser ISR links will be capable of data rates up to 10 Gbps. The laser and RF communications data rates of TSAT will result in orders of magnitude improvement in large data set timeliness, whether the transport is in-theater or around the world. The combination of high-speed links and onboard routing will mean more direct routing for users and less dependence on vulnerable ground sites.

Dynamic bandwidth resource allocation will allow users to log on to a satellite and dynamically obtain the needed bandwidth based on the information demand. When a relatively large quantity of data is ready for transmission, the user terminal will be able to negotiate additional satellite resources (or bandwidth) in order to handle the increased demand. When the need is less, the resources can be throttled back and dynamically used elsewhere to satisfy other demands. Additionally, past systems were designed with extra link margin to ensure communications under worst-case conditions; for example weather or jamming. Dynamic bandwidth resource allocation allows the system to take full advantage of the available margin based on current conditions. This will provide significant increases in system capacity and still guarantee operation under worst-case conditions.

These technologies are on track to support the TSAT development and, in combination, deliver the transformational capa-

bilities that will facilitate global network-centric operations.

Conclusion

The acquisition of TSAT is being conducted by the MILSATCOM Joint Program Office at the Space and Missile Systems Center, Los Angeles AFB. However, the acquisition is an integrated effort joining the TSAT Program Office with Commands, Services, Agencies, and other users – to include potential International Partners. The DoD and Air Force have built in program oversight and established integrated product teams to ensure that all stakeholders can participate in the transformation of communications for a new generation of warfighters. Experience in the Gulf War, OEF, and OIF has demonstrated that the data rate required per warfighter is increasing rapidly and to maintain the edge in information and decision superiority, a transformational change in space communications must move forward. TSAT will set a new standard for the integration of the space communications network with the terrestrial Global Information Grid, and will establish a high level of interoperability that lets decision makers concentrate on the information and not on the means of transport.

Portions of this article were written with support from Major Thomas Harris (SMC/MCZ), and Ms. Angela Wallace of Booz-Allen-Hamilton.

Notes:

[1] Louis A. Arana-Barradas, Teets: Air Force confident, strong, read, *Air Force Print News*. Remarks. Air Force Association, Orlando, Fla., 17 February 2005.

[2] Chairman of the Joint Chiefs of Staff (CJCS), *Joint Vision 2020*. (Pentagon, Washington D.C.: US Government Printing Office, June 2000)

[3] Peter Teets, Under Secretary of the Air Force. "National Security Space in America's Strategic Space Forces." Remarks. Strategic Space 2003 Conference, Omaha, Nebr., 3 September 2003, on-line, Internet, available from http://www.af.mil/speech/speech.asp?speechID=74.

[4] General Lance W. Lord. "Transforming Our People and Our Capabilities," Speech. National Defense Industrial Association's "Space Policy and Architecture" Symposium, 20 July 2004.

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Dr. Troy Meink is currently the Program Director, Transformational Satellite Communications System (TSAT), Military Satellite Communications (MILSATCOM) Joint Program Office, Space and Missile Systems Center, Air Force Space Command. Prior to this assignment, Dr. Meink was a program manager and senior aerospace research engineer at the US Air Force Research Laboratory Space Vehicles Directorate. In this role he was responsible for the program management of numerous technology development and demonstration programs and was chief technical advisor to the Air Force's center for spacecraft component technologies development. He also served as an Air Force officer for nine years, which included assignments as an Air Force navigator, a ballistic missile flight test engineer and a program manager. Before entering government service, Dr. Meink was a program manager and test pilot for a general aviation aircraft development program.

Book Review

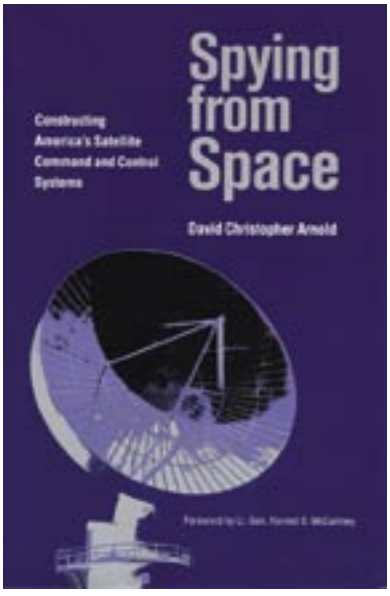
Spying from Space: Constructing America's Satellite Command and Control Systems

Spying from Space: Constructing America's Satellite Command and Control Systems. By David Christopher Arnold. College Station: Texas A&M University Press, 2005. Illustrations. Glossary. Notes. Bibliography. Index. Pp. xx, 209. $48.00 Hardcover ISBN: 1-58544-385-9

Among the dozens of space history volumes during the last fifty years, only a handful focused on the activities of the United States military or national security agencies. Even fewer specifically addressed development of the ground systems for on-orbit command and control of defense-related satellites. David Arnold's monograph *Spying from Space* fills that void by examining the history of the Air Force Satellite Control Facility (AFSCF) from its conception in the 1950s through the dramatic improvements of the 1960s. As Lieutenant General Forrest S. McCartney (USAF, Retired) asserts in the foreward, Arnold "shows that without a ground system for support, there could have been no space program."

From the moment they began thinking seriously about spaceflight, military visionaries recognized the need for ground systems to track and control orbiting satellites. This was expressed in a November 1945 report by the Navy's Bureau of Aeronautics and in RAND's May 1946 study for the future Air Force. Subsequent RAND analyses during the early 1950s, along with simultaneous efforts outside the Air Force, literally "invented" satellite command and control. In the hands of scientists and engineers faced with dissimilar situations and mission goals, that invention took different technical forms: Minitrack for the Navy's Vanguard program; JPL's Microlock for the Army's Project Orbiter, which became Explorer; and the AFSCF for the Air Force's space-based reconnaissance system. During the AFSCF's developmental stage, before its first operational use in 1959, the relatively simple idea of satellite command and control grew into a complex technological system involving economic, political, and social factors.

Several things significantly affected the AFSCF during the early 1960s. As its inventors moved to other assignments, the managers—both contractors and Air Force officers—who replaced them confronted problems associated with growth of the system. Expansion resulted in "numerous players" attempting to "win control of their own bit of the turf" and prevented prime contractor Lockheed and the Air Force from directing the entire system. Deciding that a service organization rather than a combat unit should be responsible for the satellite command and control system, the Air Force established the 6594th Test Wing (Satellite). Technical and operational challenges emerged as aging ground components and longer on-orbit lifetimes for satellites led to "an increasingly cumbersome hodgepodge of equipment and procedures." Because the Corona satellite program remained the AFSCF's sole customer, this particular command and control system evolved uniquely.



To support multiple Corona satellites in near real time for extended periods and to prepare for handling other types, such as Midas and Samos, the AFSCF underwent major improvements in the mid-1960s. The Multiple Satellite Augmentation Program standardized and simplified equipment configurations at all the remote tracking stations. It also promoted system-oriented methods for data handling and control. A second upgrade, the Satellite Test Center Interim Expansion, involved a vast number of hardware and software changes but aimed fundamentally to standardize frequencies and satellite beacons. Introduction of the mission-oriented control center concept standardized procedures for satellite operations while increasing the independence of individual satellite programs. The Space-Ground Link Subsystem during the late 1960s made the AFSCF compatible with NASA's growing fleet of space vehicles. Despite these advances toward a common-user network, the AFSCF's concentration on National Reconnaissance Office priorities drove developers of Program II—the military weather satellite—to design their own dedicated ground stations, which soon were assigned to Strategic Air Command (SAC).

Throughout *Spying from Space*, Arnold employs a social construction of technology to make several comparisons. He contrasts the test, R&D-oriented culture of the early AFSCF with the operational, mission-oriented culture of SAC and the later AFSCF, concluding that the test culture was better for problem solving but ultimately decreased flexibility in satellite command and control. Based on oral interviews and official unit histories, he addresses the quality of contractor vs. Air Force blue-suit performance. He explains how institutional and technological momentum gave the AFSCF a different character from other military space and missile command and control, thereby keeping it separate from the new National Range Division.

Although some might judge Arnold's analytical narrative difficult to comprehend because of its conceptual framework and technical density, aspiring space professionals will find it instructive. The author employed a variety of research techniques and plumbed a spectrum of source materials to produce this thought-provoking interpretation of the formation and growth of a large technological system. Perhaps the most fundamental lesson in *Spying from Space* is that the AFSCF's evolutionary path presented ample opportunities for alternative outcomes.

Reviewed by Dr. Rick W. Sturdevant, Deputy Command Historian, HQ Air Force Space Command

In Memoriam

We Walked With a Legend

General Bernard A. Schriever

1910 - 2005

In a world where it is so easy to marvel at the achievements of athletes or movie stars we sometimes miss the more monumental events of our time. These colossal events and people will go down in history because they fundamentally changed our world and the way we live. The life and accomplishments of General Bennie Schriever fit into this category.

For 94 years, Americans were privileged to share the world with a visionary leader whose achievements will stand the test of time with those of Giulio Douhet, Alfred Mahan, Sylvanus Thayer, Hap Arnold, and Billy Mitchell. A true American story, General Schriever immigrated, with his family, to our shores as a young boy in 1917. He went on to earn a degree from Texas A&M in 1931, before joining the Army Air Corps. He would realize his true calling though as Commander of the Air Force Western Development Division during the 1950s.

On numerous occasions, General Schriever was the lone voice advocating for the space and missile capabilities that many now take for granted. Like so many other pioneers, he was chastised for his outspokenness. He talked openly of Space Supremacy and Space Superiority well before the launch of Sputnik. Following one notable speech, the Secretary of Defense admonished him, "do not use 'Space' in any of your speeches in the future." After the first Soviet space launch in October 1957, everything changed.

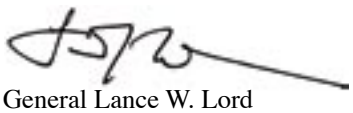
When the Nation needed him he delivered in the clutch. Future historians will look back upon the Cold War and point to General Bennie Schriever as a decisive factor in our victory. General Schriever was there when this Nation needed a measured response to Sputnik. Later on, President Kennedy was able to stand toe-to-toe with Premier Khrushchev during the Cuban Missile Crisis because of General Schriever's leadership. His determination spearheaded the development of the Minuteman missile system in less than five years and he had the system deployed in its silos by 1962. President Kennedy would later say the ICBM was his, "ace in the hole."

Today, many of the technologies once championed by General Schriever are still the bedrock of our Nation's space capabilities. Where would we be without General Schriever? Technologically, it's accurate to say we would be decades behind where we are now.

On 25 May 2005, I had the honor of presenting General Schriever with the first new "Space Badge," that will soon be worn by space and missile warriors around the world. The General's strength was leaving him as was his voice. However, the spark in his eyes could not be diminished by his failing health. The look on his face as his eyes lit up with pride reassured me that he fully appreciated the moment and its significance. This was indeed a fitting tribute to the father of our nation's space and missile forces. General Schriever will continue to be a role model for me and for so many others.

In 1962, General of the Army Douglas MacArthur delivered his now famous "Duty, Honor, Country" address, to the Corps of Cadets at West Point. General MacArthur stated, *"You now face a new world, a world of change. The thrust into outer space of the satellite, spheres and missiles marked the beginning of another epoch in the long story of mankind; the chapter of the space age. In the five or more billions of years the scientists tell us it has taken to form the earth, in the three or more billion years of development of the human race, there has never been a greater, a more abrupt or staggering evolution. We deal now not with things of this world alone, but with the illimitable distances and as yet unfathomed mysteries of the universe."* Standing on the fulcrum of mankind's greatest era of discovery stood General Bennie Schriever. Generations from now, those who wear the uniform of our armed services will regard us with envy, for we had the opportunity to walk with and stand watch with a legend.

Beccy and I join the nearly 40,000 men and women of Air Force Space Command in sending our condolences to General Schriever's wife Joni and their family. We cherish their friendship and will forever consider them a part of our Air Force Space Command family.



General Lance W. Lord
Commander
Air Force Space Command

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